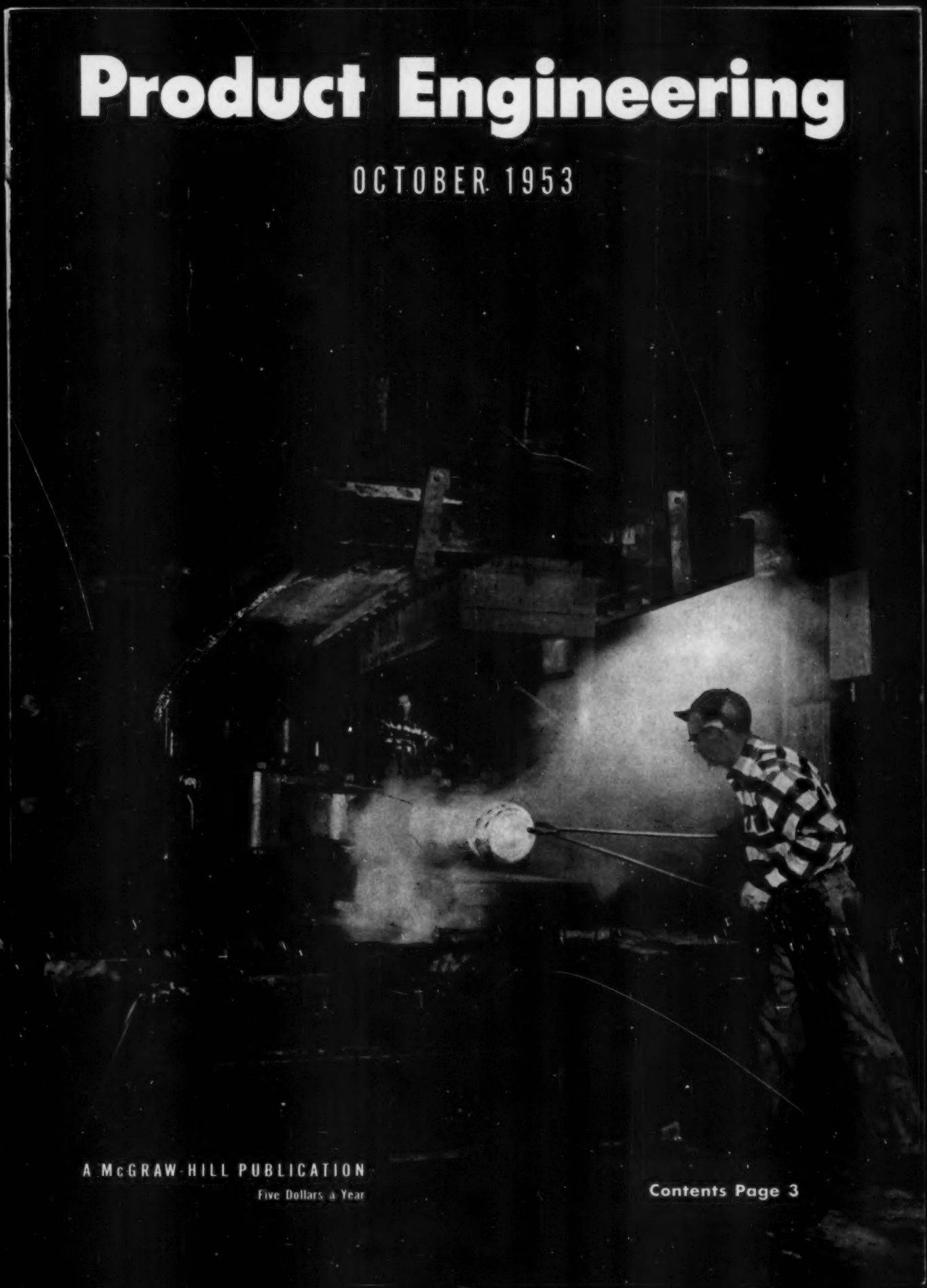
Product Engineering

OCTOBER 1953



A McGRAW-HILL PUBLICATION
Five Dollars a Year

Contents Page 3

THE LEADERS LOOK TO THE LEADER

WORLD'S LARGEST PROPELLER

is equipped with

C/R OIL SEALS

This nineteen foot Curtiss-Wright propeller (largest in service in the world) is currently installed on the Consolidated Vultee B-36 Intercontinental Bomber.

Equipped with hollow steel blades, it reverses in one second and feathers in less than three. The blades are deiced by internal flow of heated air.

The vitally important job of lubrication retention and dirt exclusion in the Blade Bearing Retention System of this great propeller is entrusted to the "Blade Nut" seal provided by Chicago Rawhide. This is a specially designed and molded C/R pressure type seal of Sirvene (synthetic rubber).

This is another example of *the leaders looking to the leader* for research, engineering and manufacture of the highest type. If yours is a particularly tough lubricant-sealing and dirt-exclusion problem, put it up to the people with most experience—Chicago Rawhide engineers.

C/R, the most widely used oil seals, are stocked in over 1800 sizes, covering 16 different types, for immediate delivery. You will find it very useful to have in your files our free handbook, "Engineering with C/R Oil Seals." Allow us to send you your copy.

CHICAGO RAWHIDE MANUFACTURING CO.
OIL SEAL DIVISION
1301 Elston Avenue Chicago 22, Illinois

● ***More automobiles, farm equipment, industrial machines, and home appliances rely on C/R Oil Seals than on any similar sealing device.***

75 C/R

PERFECT *Oil Seals*

New "Water-Saver" Valve CUTS COOLANT COSTS!

INSTANT CUT-OFF ASSURED

Now waste of expensive coolants can be eliminated . . . their use confined to required periods!

The Ross "Water-Saver" or Time Delay Valve is the answer. It turns on the coolant and lets it run when needed . . . then automatically shuts it off. The flow can be maintained for any period from 3 seconds to 3 minutes after the machine cycle.

Operation of the valve is entirely automatic. No electrical or mechanical motivation is required since it is activated by cylinder pressure.

The Water-Saver Valve is a straightway or shut-off model, normally open or closed to water supply, and is available in ¼ to 1¼ pipe sizes.

Get complete details today . . . no obligation whatsoever.

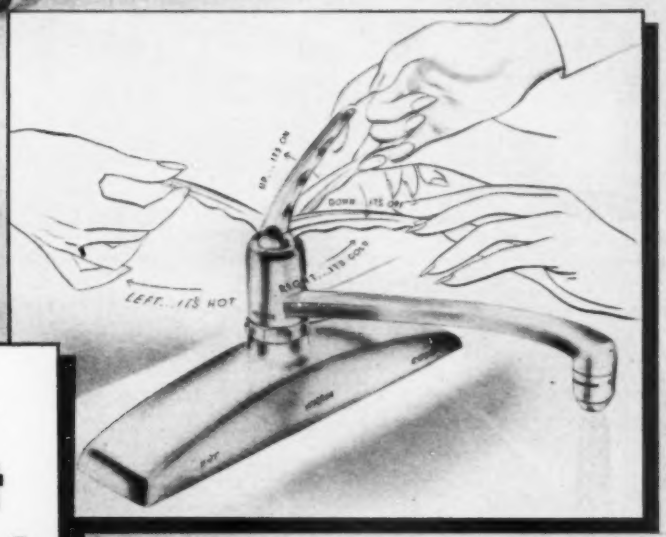
Ask Ross for Any Air Control Information

ROSS OPERATING VALVE COMPANY

Ross Air Control

114 E. GOLDEN GATE AVE., DETROIT 3, MICHIGAN

Moen Single-Handle Faucet, made by Moen Valve Co., Division of Ravenna Metal Products Co., Seattle 5, Washington.



Sketch showing operation of Moen Faucet, which can be operated by one hand, giving water at the desired temperature at any rate of flow. You can change volume without changing temperature, or change temperature without changing volume, or select the desired temperature before turning on the water. Available in various styles and types.

Faucet maker finds **unit cost more important** than cost per pound

This Moen Faucet is unusual. First, its design represents a new idea in faucets so far as we know. If we are wrong, we will welcome the correction. But in any event, this modern faucet is selling like mad; people really want its convenience, its simple operation, its one-hand control. The second unusual thing about the faucet is that the spout is made of Admiralty Metal, supplied by Revere. This metal was chosen by Moen after consultation with the Revere Technical Advisory Service, which pointed out the qualities of Admiralty from the standpoints of bendability, and plating characteristics. Everything considered, the "more expensive" Admiralty turned out to be less expensive in the end, and more satisfactory both to the Moen Valve Co. and to its customers. The faucet also uses Revere Free-Cutting Brass Rod for interior machined parts, this again being chosen for workability and corrosion resistance. Service to Moen and to many other industries in the Mountain State area is of course provided by the Revere sales, technical and mill personnel on the Pacific Coast. Similar services are of course available from Revere everywhere in this great country. To obtain the Revere services, see the nearest sales office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

Product Engineering

IN THIS ISSUE

Vol. 24, No. 10 October, 1953

High Strength Steel for Aircraft Structures 129

Silicone Putty for Slip Clutches and Couplings ..... Milton Adler 142

Designing Adhesive Bonded Joints ..... William C. Broding 144

Let's Keep Our Eye on the Ball 148

Product Designs 150

Study of Lubricant Flow in Bearings ..... Frank J. Kolano 162

Film-Type Heating Elements ..... R. E. Crump 164

Adjusting Tension of Belt Drives ..... Joseph H. Gepfert 168

Cam Dynamics ..... Douglas G. Anderson 170

Electrostatic Neutralizers ..... Robin Beach 177

High Temperature Test Data ..... Howard C. Cross 182

Sheet Metal Design With the $ Sign in Mind ..... Herb C. Golz 188

Servo Damping Techniques ..... Julius Y. Kaplan 193

How Fast Does a Spring Expand? ..... J. M. Ramrath 209

Highlights	5	New Parts and Materials	214	Sans, Souci	262
Design Perspectives	123	Meetings	252	Engineering Abstracts	266
Editorial	127	New Catalogs and Bulletins	253	Readers Letters	280
Technical News	200			New Books	292

Product Engineering

OCTOBER, 1953 Vol. 24, No. 10

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

Member of Associated Business Publications and Audit Bureau of Circulations

Published monthly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication office, 99-129 North Broadway, Albany 1, N. Y.** **Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 36, N. Y.** Donald C. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cocke, Secretary; Paul Montgomery, Senior Vice-President. Publications Division: Ralph B. Smith, Vice-President, Editorial Director; Nelson Bond, Vice-President, Director of Advertising; J. E. Blackburn, Jr., Vice-President, Circulation Director.

Subscriptions: Product Engineering—Subscription Service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Position and company connection must be indicated on subscription orders.

Single copies 50c. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $10 for two years, $12 for three years; Latin American countries, $15 for one year, $25 for two years, $30 for three years; all other countries $25 for one year, $40 for two years, $50 for three years. Entered as second class matter Aug. 21, 1936, Albany, N. Y. Post Office, under act of Mar. 3, 1879. Printed in U. S. A.

Copyright 1953 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Number of copies printed this issue 28,632

THIS MONTH'S COVER

15,000 metric ton forging press ready to apply the squeeze to a vital aircraft part. This press at Alcoa's Cleveland Works was one of the first installed under the Air Force Heavy Press Program. Built by the Schloemann Company of Dusseldorf, the press was brought from Germany by the Air Force. Weighing 1,628 tons, it is 22 ft long, 18 ft wide, and extends 18 ft below the ground and 36 ft above. The press is valued at $6,200,000.

THE STAFF

Editor
GEORGE F. NORDENHOLT

Assistant to the Editor
JOSEPH KERR

Managing Editor
VAL LAUGHNER

Associate Editors
EDWARD S. COBB
RANDOLPH P. DOMINIC

Assistant Editors
ROBERT E. ABBOTT
PAUL N. ANDERSON
ROBERT W. BRULEY
BYRON K. LEDGERWOOD
NORMA J. VAN NESS
STEPHEN J. WILSON
LEWIS H. YOUNG

Editorial Assistants
DONALD M. MARTIN
LILLIAN M. WITHAM

Consulting Editor
ROBERT E. BRUCKNER

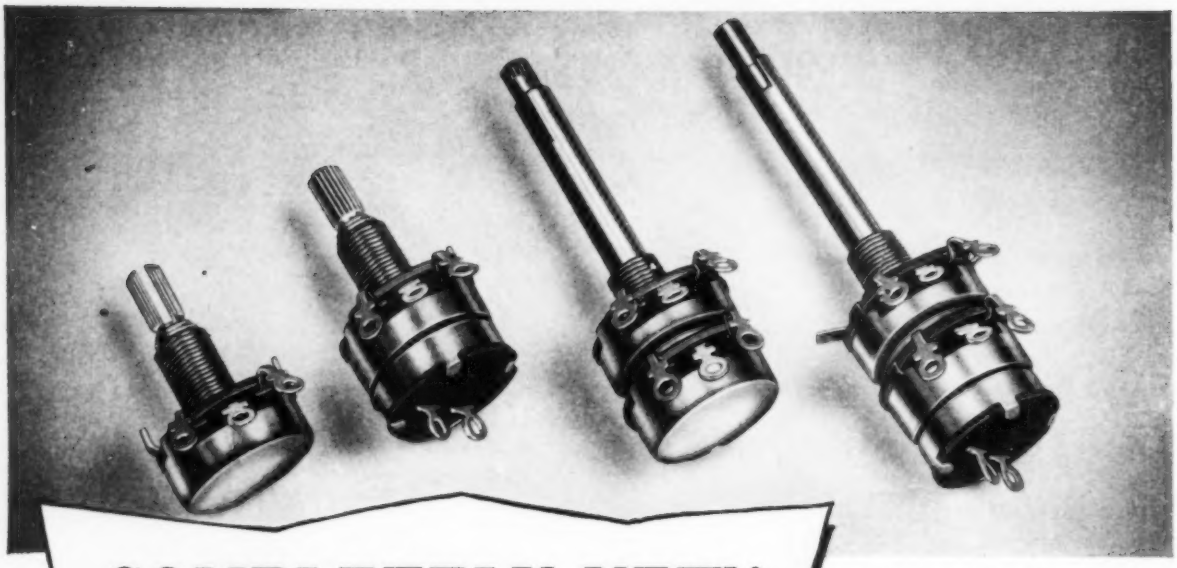
Washington
GEORGE B. BRYANT, JR.

Publisher
ALBERT HAUPTLI

Advertising Sales Mgr.
STANLEY J. ALLING

Service Mgr.
HUGH BRITTON

Foreign News Bureaus:
LONDON • PARIS • BERLIN
MOSCOW • TOKYO
MELBOURNE • SOA PAULO
BUENOS AIRES • MANILA



COMPLETELY NEW!

The new Mallory line is complete. Single, dual concentric and dual tandem constructions are available—with or without switch. Resistance values range from 250 ohms to 10 megohms.

A Complete Line of Mallory Carbon Controls ...Including a Dual Control with Switch Attached

You will get new standards of long life, quiet operation and stable, precise resistance values with these new Mallory Carbon Controls.

An entirely new type of carbon element, with unusually high density and surface smoothness, holds resistance drift to 10% and keeps noise level to a minimum. Service life is substantially increased.

In addition to superior electrical characteristics, these controls have a new welded construction, heavier fastenings, and firmly clinched terminals that defy vibration and normal usage. Special silver contactors and heavy terminals assure long, trouble-free switch life.

Whether your models are in production or on the drawing board, get all the facts now on these new controls. A new Technical Bulletin with complete specifications is yours for the asking. Or, call your Mallory Sales Engineer. He will be glad to work with you . . . show you how these new controls can give better performance and keep your costs down.

NEW MALLORY AXIAL-LEAD, CERAMIC RESISTORS that are HIGH in quality . . . LOW in cost

These new resistors are designed especially for television and radio applications where high quality and low cost are important. They are conservatively rated . . . will withstand overloads up to 100% of rated value. New Technical Bulletin on request.

Expect more . . . get more from MALLORY

Parts distributors in all major cities stock Mallory standard components for your convenience

P.R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., INDIANAPOLIS 6, INDIANA

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

METALLIC MATERIALS

. . . The output goal of titanium sponge has been revised upward from 25,000 to 28,000 tons by the Office of Defense Mobilization. This production will be required by 1956 to meet military demands for the metal. The rapid expansion will necessitate further study of the production capacity to determine whether the increased production will be adequate. Several new companies have expressed an interest in producing titanium, and Dow Chemical and Horizons Titanium are in the pilot plant stage.

MAGNESIUM BEARINGS . . .

. . . Proper alloy selection, heat treatment and surface coating will increase the wear resistance of magnesium. Dow Chemical Co., has found that magnesium bearings can be used directly as bearing material without using bushings or inserted bearings. Tin, lead, and cadmium-lead are the best alloys to use. The three coating types used are plating, chemical treatments and anodic coatings, and metal sprays.

HARDENABILITY CONTROL . . .

. . . Hardenability bands are in the process of revision and will give steel users the benefit of more closely controlled hardenability in thin sections. The SAE reports the narrowing of the bands was made possible by narrower carbon ranges of all steels and widened manganese and chromium ranges for single and double alloy steels. Revisions are based on data obtained from over 40,000 heats of steel.

TITANIUM CARBIDE . . .

. . . Titanium carbide sintered with nickel, cobalt and iron base alloys results in a material that has unusually good high temperature properties. Kennametal Co., Latrobe, Pa, reports that the stress rupture strengths are more than double those of other commercial alloys at 1,600-1,800 F. Its oxidation resistance at 1,800 F is also excellent.

PRECIOUS CONTACT MATERIAL . . .

. . . A precious metal contact material, laminated in ingot form through heat and pressure and then cold rolled to required dimensions, has been developed by D. E. Makepeace Co, Attleboro, Mass. The material consists of one or more ingots of precious metal bonded to a base metal. The metal is hard rolled to produce dense, hard contact surfaces with good electrical and mechanical qualities. The contact material is slated for use by G. E. on its latest line of a-c motor starters.

ALUMINUM AND REACTORS . . .

. . . Because of light weight, good corrosion resistance, low neutron absorption rate, efficient heat transfer and the ability to bond with uranium, aluminum is being used more and more in nuclear reactors. Reynolds Metals Co. reports it is being used in the form of tube to carry coolant water to the pile; as a coating in the form of a thin mechanical jacket for the rods; and as a reactor where uranium alloy plates are clad with aluminum.

HIGH TEMPERATURE METAL . . .

. . . Development of a new compound, named molybdenum di-silicide, is for use by the ceramic and glass industries. Electro Metal Corp., Yonkers, N. Y., and the Metallwerk Plansee of Reutte, Austria report that one of the first uses of the metal will be as heating elements in furnaces for making glass, ceramics and other high melting materials. Tests indicate the metal will withstand 3,000 F and the use of a vacuum is not necessary. The compound resists oxygen.

NONMETALLIC MATERIALS

. . . A conductive ink for printing circuits on a plastic base has been developed by J. Frank Motson Co., Flourtown, Pa. The ink permits direct printing of conductive silver circuits that can be soldered by dipping or by soldering iron without electroplating. The circuits show good bond to such base materials as phenolic, polyester-glass fiber, silicone-glass-fiber, ceramics, glass and Mylar.

BONDING ALUMINUM . . .

. . . A thermosetting epoxy resin formulation for use in bonding aluminum to aluminum with only contact pressure and at moderate temperature is a development of the Armstrong Products Co., Warsaw, Ind. Advantages claimed are: strength, which often exceeds 3,000 psi at room temperature; high resistance to impact; and ability to be cured at room temperatures in a short period of time.

(continued on page 7)

thermosetting plastics a *Question Mark* to you?

HERE'S A WELL-KNOWN *Answer Mark!*

It's a mould mark—ours. And it's a sign of good source for thousands of manufacturers who use moulded plastic parts.

Here are our qualifications for *your* thermosetting assignments: 1) 36 years' *experience* as planners and moulders in plastics; 2) *specialization* in thermosetting standard materials or new ones like Teflon and glass reinforced moulding compounds; 3) enviable skill in *design* for compression, transfer and plunger moulding methods; 4) *capacity* for production-schedule delivery.

There's a fifth qualification we think is worth mentioning. We're not too proud to recommend specialists in *other* moulding methods if a review of your job suggests it. Will you phone or write us—or one of our offices?

Kurz-Kasch, Inc. • S. Broadway • Dayton 1, Ohio

BRANCH SALES OFFICES: New York, Lexington, 2-6677 • Rochester, Hillside 4352 • Chicago, Merrimac 7-1830 • Detroit, Trinity 3-7050 • Philadelphia, Hilltop 6-6472 • Dallas, Logan 1970 • Los Angeles, Richmond 7-5384 • St. Louis, Delmar 9577 • Toronto, Elgin 4167
EXPORT OFFICE: 89 Broad Street, New York City, Bowling Green 9-7751

Kurz-Kasch
FOR OVER 36 YEARS PLANNERS AND MOULDERS IN PLASTICS

Highlights ~

ZIRCONIUM DIOXIDE STABILIZED . . .

. . . A new technique for stabilizing zirconium dioxide, a high temperature ceramic that can withstand over 4,000 F, has been developed by the Air Force Laboratory at Dayton, Ohio. Special additives permit stabilization at a lower temperature and should permit new and cheaper manufacturing methods and new uses for the material. Zirconium dioxide should become increasingly important in the future for rockets, turbo-jets and high-temperature metallurgical research where temperature is a factor.

INSULATING COATING . . .

. . . Capable of being sprayed like paint, a new rapid-drying material for treating metal surfaces that can withstand temperatures to 5,000 F is a development of B. F. Goodrich Co., Akron, Ohio. It is claimed that a 1/16 in. coating will protect metal for 10 sec against flame temperatures hotter than the melting point of the metal. The coating is reported to be non-toxic, non-flammable, non-explosive and will adhere directly to clean metal surfaces. The material will withstand indefinitely temperature cycles of minus 60 to plus Fahrenheit.

HEAT-INSULATING PLASTIC . . .

. . . Manufacture of heat-insulating material by subjecting methacrylate plastic to atomic radiation is suggested by experiments at Britain's Atomic Energy Research Establishment. When the plastic was tested in the atomic reactor or exposed to a pure gamma radiation from a cobalt-60 source, it took on an expanded form. In some instances after radiation, the material expands on heating. It is thought that when placed inside containers after being irradiated, and then expanded by heating, it will give a complete filling of the required space.

PROCESSES

. . . A silver plating process for aluminum joints, to improve the performance of Switchgear equipment, is a development of General Electric Co. The silver is atomically bonded to the aluminum by electroplating after the surface is first coated with zinc by a chemical process. By using this process, a silver surface replaces the aluminum surface in the contact area, eliminating the oxide film which forms on bare aluminum in contact with air and causes a high electrical resistance.

FABRICATION OF TITANIUM . . .

. . . A barrier to the wider use of titanium has been the brittleness of the metal. General Electric reports that drop forging can be carried out without shattering if the blanks are first heated in an induction coil. Also, caustic descaling causes a loss of ductility in bending, but sandblasting does not have this affect. In annealing, close temperature control will offset the rapid grain growth tendency which is one reason for failure of titanium welds, not in the fusion area but in the heated zone.

BLAST FURNACE STUDIES . . .

. . . A research project on the use of low-shaft blast furnaces will be undertaken by the U. S. Bureau of Mines at Pittsburgh, Pa. The feeling is that economic production of pig iron in small quantities using low-grade fuel is adaptable to areas having small deposits of iron ore, a source of low-grade fuel, and limited pig iron requirements. Also, some consumers, such as foundries and nonintegrated steelmakers, could use low-shaft furnaces to produce pig iron for their own use at a substantial saving.

ADDITIONAL RUBBER STRENGTH . . .

. . . An improved process for compounding rubber has been developed in the laboratories of Canada's National Research Council in Ottawa. By adding a compounding ingredient consisting of lignin and certain oxides of metals, a rubber with a Bashore resilience of 65 percent and a tensile strength over 5,000 psi is produced. The metallic oxides are litharge, brown lead, red lead, copper oxide and bismuth trioxide. The oxides inhibit the cure delaying action of lignin and enhance the tensile strength.

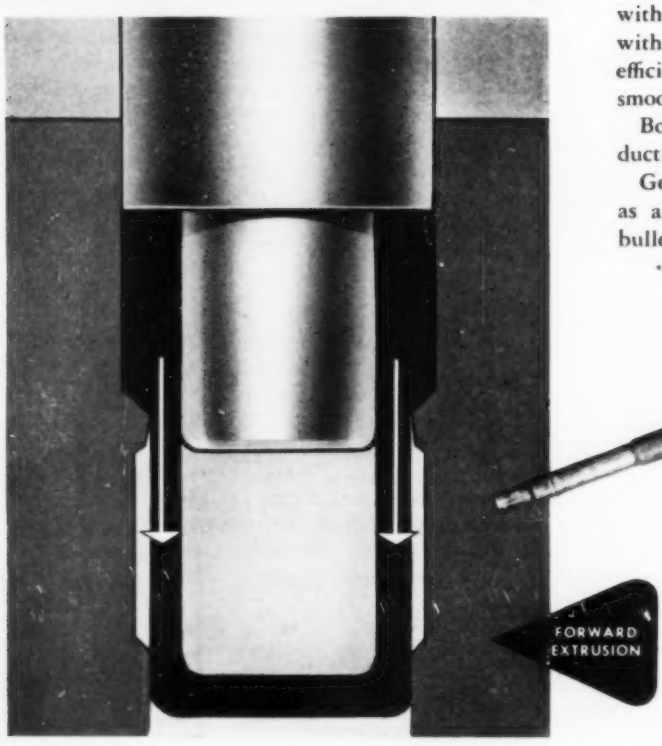
VACUUM PROCESS . . .

. . . The shortage of nickel and chromium has renewed industry's interest in the vacuum process for coating metals. National Research Corp, Cambridge, Mass., is considering the application of nickel and chromium by the vacuum process (rather than by electroplating) to such items as automobile bumpers, window flashing and other exterior trim. The process is being used by the electronics industry for many items. Advantages claimed are smaller amounts of coating materials and low operating costs.

ALUMINUM STRETCHER . . .

. . . A 5,000,000 lb capacity machine for the stretching of high strength aluminum alloy plate will be operated by Kaiser Aluminum rolling mill at Trentwood, Wash. Machine is to flatten plate and relieve residual stresses resulting from rolling and heat treatment. This will be especially useful to the airframe industry because of the trend toward integrally-stiffened large structures. Stretching provides material that may be machined with a minimum of distortion.

(continued on page 9)



Extrusions are easier...

with BONDERITE and BONDERLUBE

Many metal parts and products, previously regarded as impossible extrusions, are now successfully cold formed with the aid of Bonderite and Bonderlube.

Bonderite creates a nonmetallic coating integral with the surface of the metal. Bonderlube then reacts with the Bonderite to coat the work with a highly efficient dry-type lubricant which makes metal flow smoothly in the dies.

Bonderite and Bonderlube promote increased production, top quality and real economy.

Get full information on Bonderite and Bonderlube as aids in cold forming of metals. Write for free bulletin.

*Bonderite, Bonderlube, Parco, Parco Lubrite — Reg. U.S. Pat. Off.

Since 1915— leader in the field

Parker RUST PROOF COMPANY

2179 E. Milwaukee Ave., Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces

Highlights ~

COMPONENTS

. . . Reduced vibration and structure-borne noise from grinders, motor-generator sets, high-speed compressors, fans and blowers are claimed for a vibration isolator. The Barry Corporation, Watertown, Mass, says the unit gives efficient isolation at frequencies above approximately 20 cps at static loads of 15 to 200 lb per unit isolator. Within its recommended load, the unit provides 70 to 90 percent isolation at 30 cps and more at higher frequencies.

TRANSFORMER CORE . . .

. . . A precut, preformed core for small power transformers that improves performance and reduces transformer size and weight has been developed by G. E. The core, made of oriented, cold-rolled silicon steel, provides greater flexibility in design. Losses, exciting current, noise level, weight and dimensions can be varied to suit operating conditions. To take full advantage of the highly directional properties of the core steel, the low-strain efficient magnetic circuit of the preformed core was developed.

HARDNESS TESTER . . .

. . . Two functions, setting the load and measuring the depth of penetration, are performed by a single mechanism according to British Patent No. 693,348 for a new hardness tester. A chamber is filled with mercury and connected to a horizontal capillary glass tube. Action of the mechanism causes mercury movement in the tube and thus measures of the hardness of the specimen are made in a single operation.

MEASURING INSTRUMENT . . .

. . . Power measurements can be taken in such high-temperature systems as rocket motors or jet engines without burning out the measuring instrument. Control Engineering Corp., Norwood, Mass., reports the device can withstand gas temperatures in excess of 5,000 F and can detect fluctuations in pressure that occur in 1/10,000 of a second.

TESTING

. . . Marine exposure tests on limited quantities of unalloyed titanium and zirconium sheet coupled with high strength aluminum alloy have been conducted by Saunders-Roe Ltd., England. Marked corrosion of the aluminum alloy sheet after a two months exposure was noticed. Zinc chromate paste was used between the faying surfaces but did not provide adequate protection against galvanic corrosion. The results seem to indicate that full precautions should be taken in designs using titanium or zirconium with aluminum alloys. Similar exposure tests are planned using titanium and zirconium sheet coupled with aluminum alloy in other types of atmospheres.

BRAZING FLEXIBLE HOSE . . .

. . . Tests indicate that for maximum point strength and service life, the best bond between flexible metal hose and couplings is obtained by silver brazing where high pressure and medium temperatures are significant factors. Titeflex Inc, Newark, N. J., claims that the parts are not heated enough to cause excessive annealing; the rapid flow of the silver solder provides a greater area of bond and a strong seal; and the joints are dependable throughout the temperature range.

SYNTHETIC LUBRICANTS TESTED . . .

. . . The use of these may replace petroleum oils to meet the high demands of aircraft turbine engines. Existing lubricants, according to the Lewis Flight Propulsion Laboratory, are either too viscous for adequate pumping at low temperatures, or have marginal lubricating ability and excessive volatility at operating temperatures. Lubricants that show promise are a silicone-diester blend, a diester compounded with additives, and a blend of di-sebacate in a silicone fluid.

GAS REMOVAL FROM AL-CLAD . . .

. . . Blistering of aluminum-clad plates by hydrogen absorption during melting and release during heating can be greatly reduced. Tests conducted by the Oak Ridge National Laboratory claim reduced blistering if the plates are first dipped in an alcohol slurry of halide aluminum brazing flux, dried at 300 F and heated for 1 hr at 1,100 F. Rejects were less than 1 percent for the plates used in the test.

TURBINE TESTER . . .

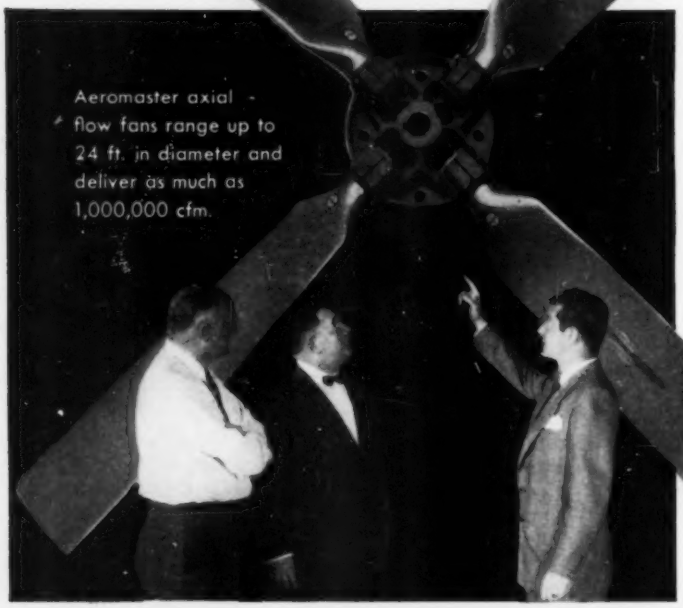
. . . . A machine that simulates the heat and vibration conditions that affect gas turbine blades has been developed by the General Electric Company. Once rotating, a vibration is introduced and a stroboscopic light used to "stop" rotation and measure bucket oscillation. Recording instruments relay further metal strain data to tapes for later study. Another important use of the machine is to study vibratory forces.

STEEL RESEARCH . . .

. . . A new research laboratory to study the weldability characteristics of high alloy steels has been dedicated by Allegheny Ludlum Co. Applied research into all phases of high alloy steel welding will be studied.

DUCTALLOY® CASTINGS GIVE KOPPERS FANS

Strong, Sound Hubs



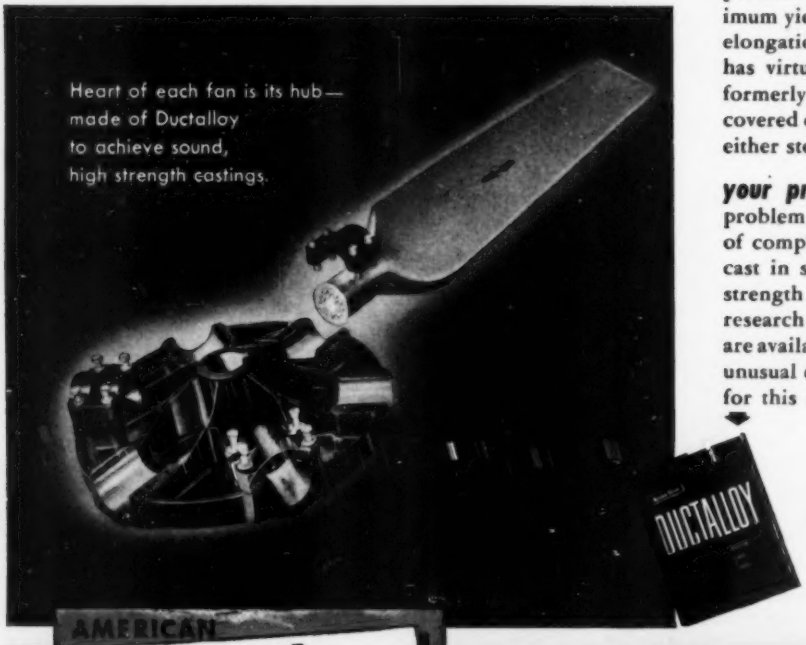
Aeromaster axial - flow fans range up to 24 ft. in diameter and deliver as much as 1,000,000 cfm.

EASILY CAST, EASILY MACHINED

High performance fans made by the Aeromaster Fan Department of Koppers Company, used in cooling towers near diesel engines and compressors, must withstand considerable applied vibration in addition to normal operating loads. For this reason cast steel was originally specified to provide the necessary hub strength; but machining costs were excessive, surfaces were poor, and too many castings were "lost" when machining revealed hidden defects. A switch to malleable iron only aggravated the problem of casting soundness. The answer was Ductalloy 60—Brake Shoe's easily machined high strength ductile cast iron.

MACHINE SHOP REJECTS ENDED

Ductalloy 60 is a ferritic iron having 60,000 psi minimum tensile strength, 40,000 psi minimum yield strength and 10% minimum total elongation, all guaranteed. Use of this material has virtually eliminated the high scrap loss formerly encountered when defects were uncovered during machining of castings made in either steel or malleable iron.



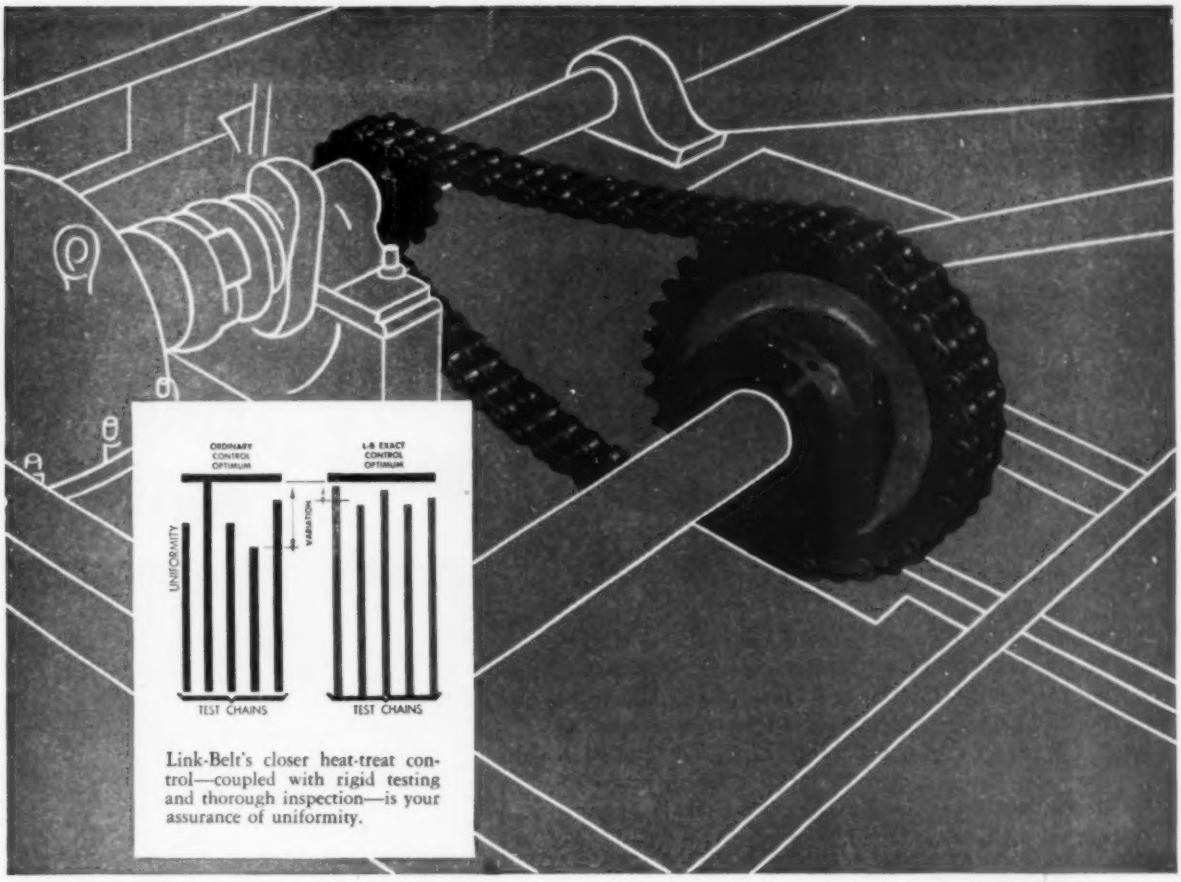
Heart of each fan is its hub—made of Ductalloy to achieve sound, high strength castings.

your problem — Ductalloy may solve your problem if it involves economical production of complex metal shapes that are difficult to cast in steel, expensive to forge or lacking strength in gray iron. Brake Shoe's experience, research laboratory and experimental foundry are available to help you best utilize Ductalloy's unusual combination of characteristics. Write for this new technical bulletin today.

DUCTALLOY castings are made by:
BRAKE SHOE & CASTINGS DIVISION
ENGINEERED CASTINGS DIVISION

AMERICAN **Brake Shoe** COMPANY

230 PARK AVENUE
NEW YORK 17 • NEW YORK



Link-Belt's closer heat-treat control—coupled with rigid testing and thorough inspection—is your assurance of uniformity.

Closer heat treat control means longer roller chain life!

But it's only one of many engineering extras you get from LINK-BELT

THE long-life record of Link-Belt Precision Steel Roller Chain is based on more than closer heat treat control. Consider such extra-wear features as shot-peened rollers and lock-type bushings. They're further assurance of Link-Belt's *built-in* extra life.

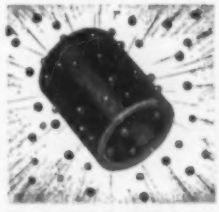
Link-Belt Roller Chain is available in single or multiple widths, ⅜" through 3" pitch. Double pitch, 1" through 3". For all the facts, call the Link-Belt office near you today, or write for Data Book No. 2457.

LINK-BELT

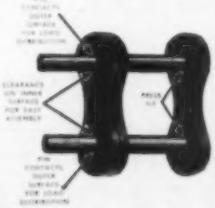
ROLLER CHAIN & SPROCKETS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,120

Don't overlook these other LINK-BELT extras



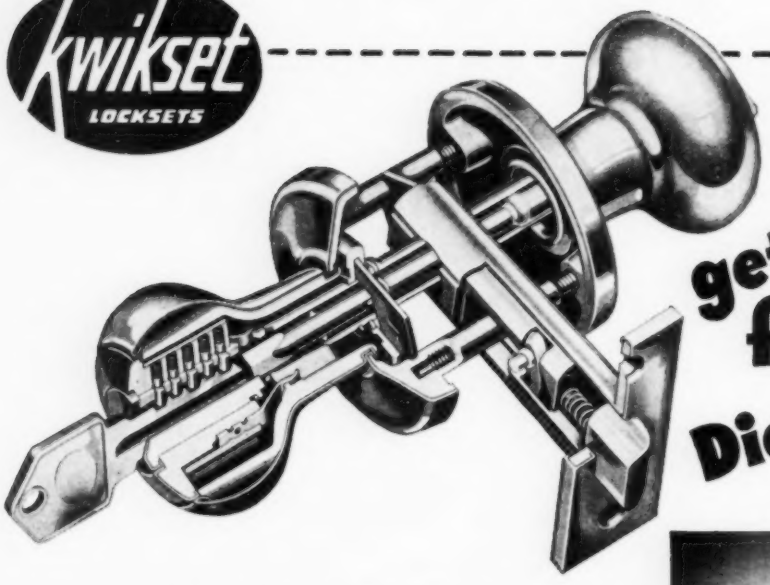
Shot-peened rollers have extra fatigue life for higher speeds, heavier loads.



Couple, uncouple multiple-width chains easily.

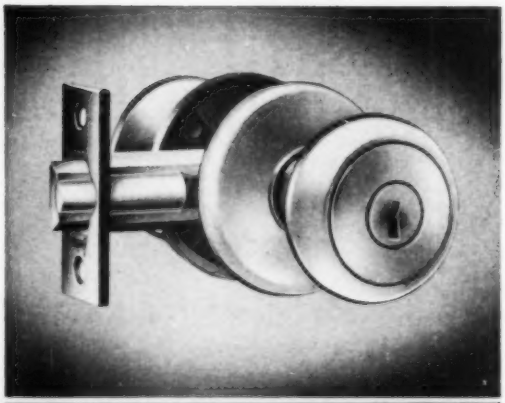
Lock-type bushings assure free articulation.

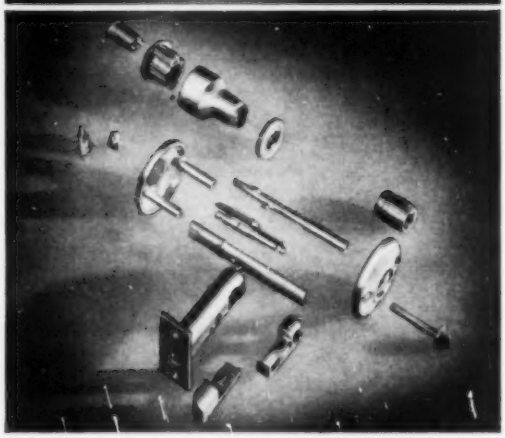
Kwikset LOCKSETS



provide a key to-

get the mo$t for your Zinc Die Ca$ting Dollar!





Attractive in design and beautifully finished in polished brass*, this lockset has also been engineered for precise, but rugged, construction at minimum cost. This combination of properties, achieved largely by the use of ZINC Die Cast components—16 in all—has resulted in the sale of millions of the locksets for private residences and large-scale housing developments throughout the U. S. and abroad.

The plain fact of the matter is that no metal and method of production other than ZINC Die Casting could turn out the lockset parts (lower right) with equal properties at comparable cost. Thanks to the complexity of shape possible with ZINC Die Castings, one part is made to serve in place of several—with impressive savings in both machining and assembling. Close tolerances, as cast, insure perfect fit of mating parts, and the inherent strength of ZINC provides the dependability so important in this type of product.

In selecting a die casting alloy there are many factors —both physical and mechanical—to be considered in addition to the base price of the metal. Ask any commercial die caster about the advantages of ZINC Die Castings—or write to us.

*Also available in polished chrome, or in satin brass, bronze or chrome.

The New Jersey Zinc Company
160 Front St., New York 38, N.Y.

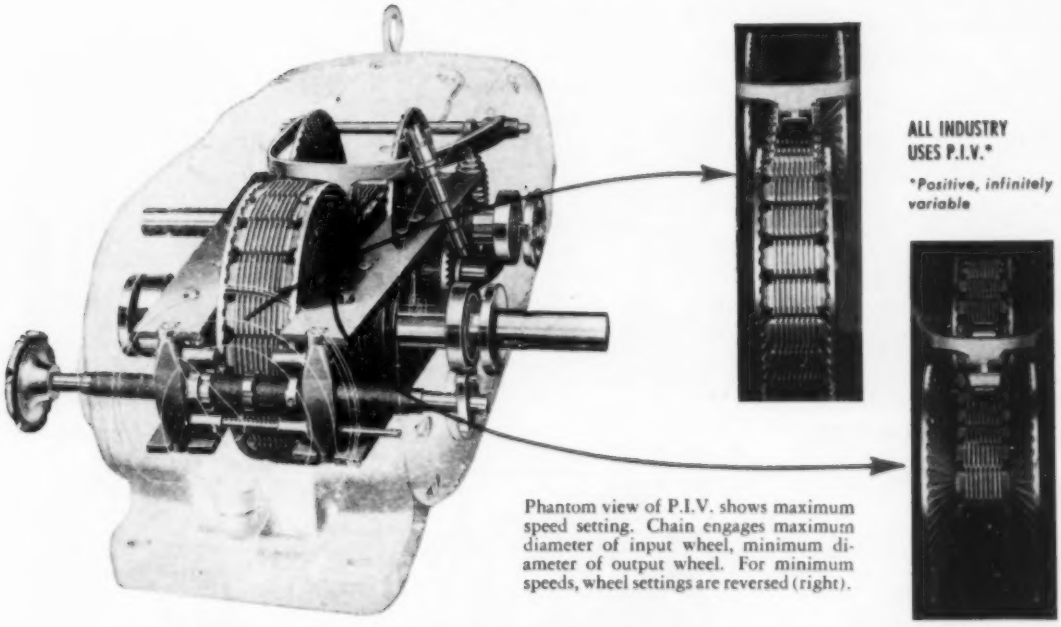
Send for your copy

ZINC
FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

How you can get speed changing that's

truly POSITIVE truly STEPLESS



ALL INDUSTRY USES P.I.V.*

*Positive, infinitely variable

Phantom view of P.I.V. shows maximum speed setting. Chain engages maximum diameter of input wheel, minimum diameter of output wheel. For minimum speeds, wheel settings are reversed (right).

LINK-BELT's P.I.V. operates independent of friction ... gives you exact selection of an infinite number of speeds

TURN a hand wheel . . . push a button . . . or utilize fully-automatic controls. Link-Belt's P.I.V. Variable Speed Drive provides the speed you need—without stopping the machine. Speed changing is positive, stepless—accurate under full load. Speed choice is infinitely selective, effortless and precise.

P.I.V. is not dependent on friction for power transmission. Link-Belt's exclusive self-tooth-forming chain meshes with grooved wheels to assure positive power transmission at all speeds. Full-rated horsepower is constantly delivered to your machines.

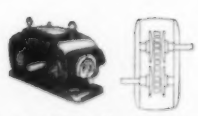
If your manufacturing processes demand variable speed control, get all the facts about these compact P.I.V. Variable Speed Drives. There's an experienced power transmission engineer in the Link-Belt office near you. Call him today. Send for Catalog No. 2274.

LINK-BELT

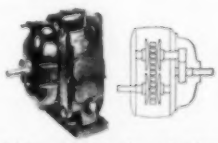
P.I.V. VARIABLE SPEED DRIVE

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,117

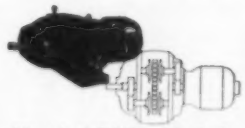
4 of 16 P.I.V. types you can choose from. ½ to 25 hp . . . ratios to 6:1



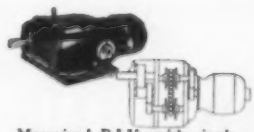
Basic P.I.V. Like all others, it is built for horizontal or vertical mounting.



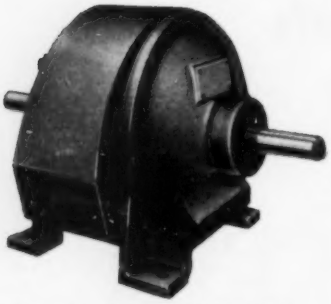
P.I.V. with single reduction input or output helical gears.



Motorized P.I.V. with single reduction input and output helical gears.

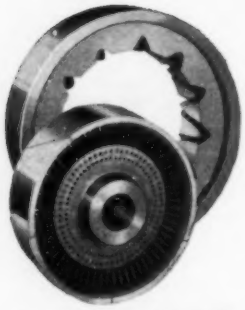


Motorized P.I.V. with single reduction input and double reduction output helical gears.

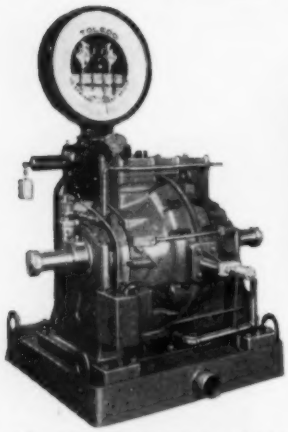


AIR COOLED COUPLINGS

AJUSTO-SPEDE MOTORS



AIR COOLED BRAKES



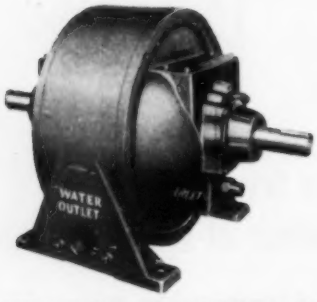
ABSORPTION DYNAMOMETERS

EATON

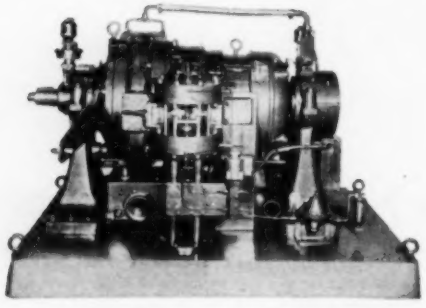
DYNAMATIC

EDDY-CURRENT ROTATING EQUIPMENT

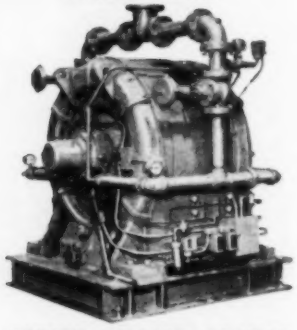
PRESS DRIVES



LIQUID COOLED COUPLINGS



UNIVERSAL DYNAMOMETERS



LIQUID COOLED BRAKES

Dynamatic Eddy-Current electro-magnetic equipment represents the ideal solution for a wide range of adjustable-speed drive problems, particularly where an AC power source is a requirement. Typical applications include paper machine drives, cement mill drives, industrial truck clutches, press drives, crane brakes, fan drives—in fact, practically all test, processing, and conveying equipment common to industry. Instantaneous response and accurate control are important advantages.

Write for your copy of Bulletin GB-1 which describes and illustrates the basic Dynamatic units.

DYNAMATIC CORPORATION KENOSHA • WISCONSIN

Subsidiary of EATON MANUFACTURING COMPANY, Cleveland, Ohio

MADE FOR GREATER SERVICE

through greater service

Greater service from custom molded or extruded rubber parts comes from the greater service Goodyear gives you throughout their design and production.

From drawing board to delivery, your product gets the special attention of Goodyear's experts in getting the most out of rubber.

The G.T.M.—Goodyear Technical Man—serves you with his long and varied experience in designing rubber to do a better job longer in many uses in many industries.

Goodyear's corps of chemists and engineers serve you with their complete knowledge of compounding and processing rubber to meet virtually any specification or service requirement.

And thousands of production workers serve you with their unparalleled experience in turning out all types of rubber parts—on time and on "spec"—with modern equipment in modern plants.

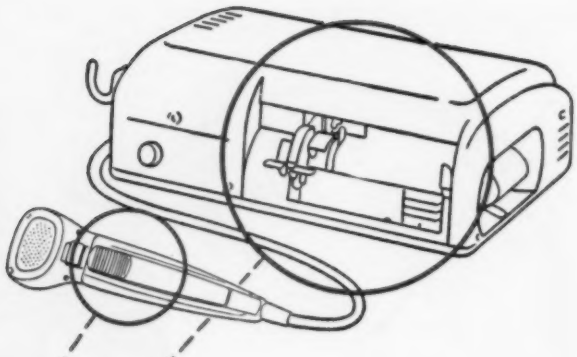
For greater service from parts made of rubber or rubber-like plastics—or combinations of rubber and metal, rubber and fabric or rubber and plastic, use the greater service offered by Goodyear. Consult your G.T.M., or write to Goodyear, Molded Goods Dept., St. Marys, Ohio or Los Angeles, California.

YOUR GOODYEAR DISTRIBUTOR *can quickly supply you with Hose (air, water, steam, oil, special), Belting (V-belts, transmission, conveyor, elevator), and other industrial rubber products. Look for him in the yellow pages of your telephone directory under "Rubber Products" or "Rubber Goods."*

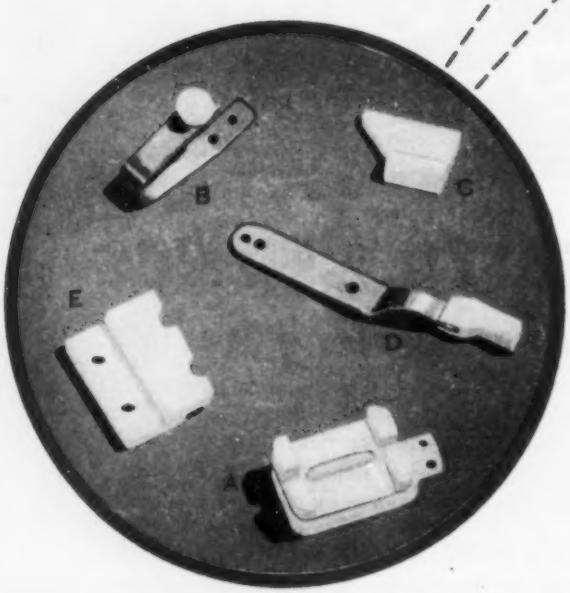
GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network



Parts of Du Pont nylon resist wear and abrasion



Parts molded of Du Pont nylon for the Dictaphone Corp., New York, N. Y., by Watertown Mfg. Co., Watertown, Conn., and Bridgeport Plastics & Rubber Co., Bridgeport, Conn.

... need no lubrication ... have excellent dielectric properties ... improve performance

Here's how key parts of Du Pont nylon have improved the performance of the Dictaphone Corporation's new Time-Master dictating machine. The *recorder coil bobbin* (a) is molded of Du Pont nylon because nylon is strong and tough in thin sections and has excellent insulating properties. Terminals can be riveted directly to it—eliminating an insulating part and cutting assembly time. The *microphone hook actuating lever* (b) required a material with good thermal stability. Molded nylon withstands high operating temperatures (up to 250°F.). These UL approved parts are tough, too—stand up to hard usage without cracking or breaking.

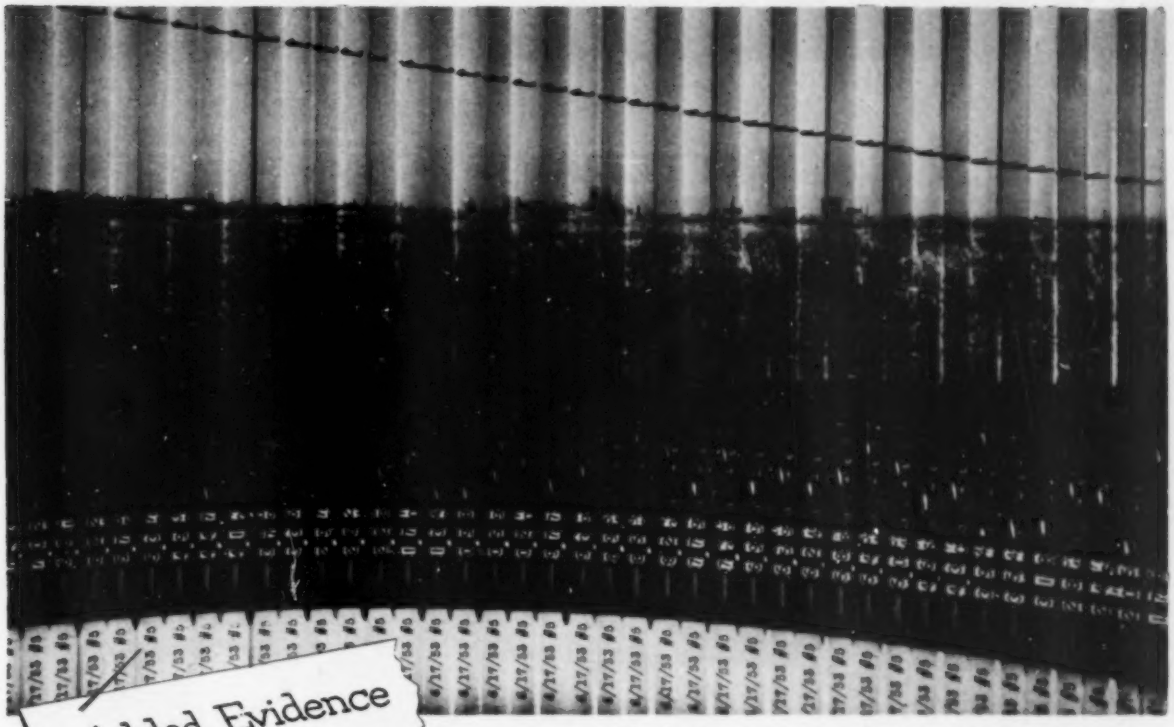
The *switch actuator* (c) and *playback actuator* (d) in the microphone utilize Du Pont nylon's easy moldability. In the switch actuator, the nylon part is used as a die insert, and the microphone handle is then molded around it. This process eliminates an assembly step and makes a virtually unbreakable joint. For the playback actuator, nylon is molded around a metal insert. These parts operate smoothly and silently without lubrication . . . resist wear over long periods.

In the *microphone sliding lock lever* (e) Du Pont nylon assures a part that slides easily and provides a slip-free, long-wearing lock. All five parts are economically produced to close tolerances by injection molding. They help lower production time and costs . . . save on assembly and maintenance.

Perhaps the unique combination of properties of molded Du Pont nylon can help you improve the design and operation of your product. For further information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 1010, Du Pont Bldg., Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

Here's how to plot a plane's Angle-of-Climb...



Added Evidence that—

Photo by Sherman Fairchild & Associates' Flight Analyzer Camera, New York City

Everyone Can Count on VEEDER-ROOT

New take-off technique yields an 8° climb, as this progressive *single photo* shows. And this is 100% improvement over old techniques . . . increasing safety and decreasing noise-annoyance at city airports.

Here you actually see 53 separate exposures. And each, reading from bottom up, shows the date and number of the flight photographed. Next above is a device which records the time ...exact to 1/1,000th of a second. And in the heart of this device is a Veeder-Root Counter.

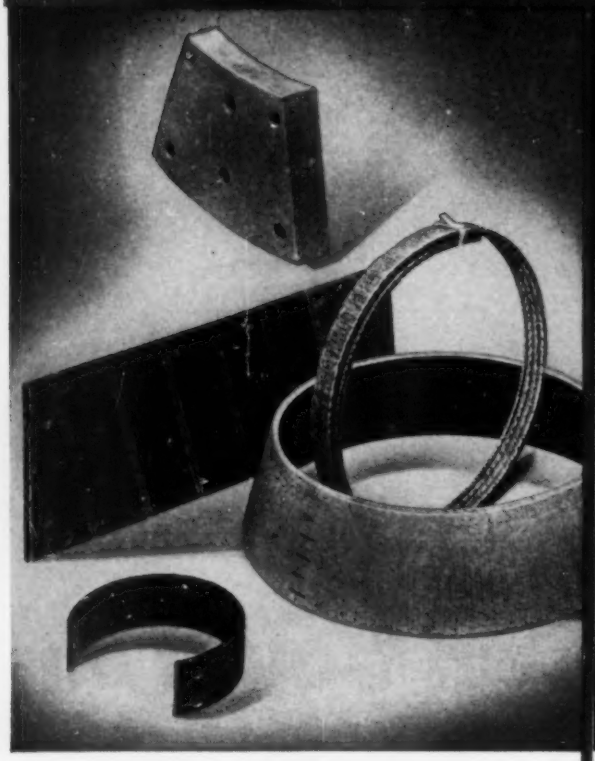
So here again you see one of the heretofore uncounted ways in which "Everyone Can Count on Veeder-Root". What's *your* problem? Let us put our mathematical eyes on it. Write:

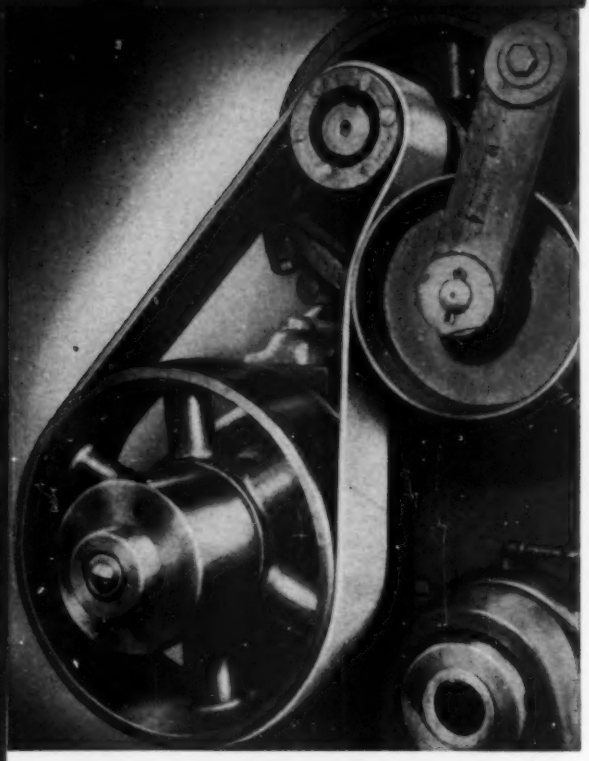
VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

R/M Design people find Raybestos-Manhattan engineering service helpful on problems involving Asbestos, Rubber, Sintered Metal and Teflon* Products





Friction Materials

In the factory, on the farm, on the highway, even in the home . . . Raybestos-Manhattan friction materials contribute to the successful solutions of hundreds of "Stop and Go" problems. In the complete R/M line designers can find brake linings, brake blocks, clutch facings, bands, cones and many special shapes . . . precision-made of woven or molded asbestos or of various formulations of sintered metal. Each part is unique in design, size, composition, friction and engagement characteristics, and in suitability for a specific type of service. The parts illustrated above merely suggest the wide range of shapes and sizes available.

Mechanical Rubber Products

Raybestos-Manhattan has continually kept ahead of changing demands in the development of mechanical rubber products. The Condor Whipcord Endless Belt is an example of industrial foresight at R/M. This transmission belt has been known to outlast from 2 to 10 ordinary type endless belts on many drives. Made from strong de-stretched cords, endless wound and embedded in rubber, it is a highly flexible belt, unaffected by temperature changes. The exclusive Manhattan Extensible-Tip prevents cover splice separation by extending the joint stress over a wide area. The same R/M ingenuity in engineering applies to hose, conveyor and V-belts, molded rubber products.

Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

Mechanical Packing and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

Rubber Lined and Covered Equipment

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL

To better serve you PROMPTLY.. So that R/M sales, research, engineering and production can best coordinate to handle your problems . . . and so that we can serve you with least delay . . . please wire, phone or write the division listed under the product in which you are interested.

Packings, Gaskets,
Asbestos Textiles and Teflon* Products

Here are a few of the hundreds of different R/M packings and gasket sheets. Raybestos-Manhattan makes available to design engineers a complete line of packings made of rubber, duck and rubber, flexible metal, plastic, asbestos, ramie, flax and other fibers to seal against air, water, steam, gas, oil, solvents, foods, hydraulic fluids, etc. R/M also manufactures asbestos textiles, woven yarns and cloth. And R/M meets specifications for Teflon packings, rods, sheets, tubes, tapes and fabricated parts.

**Du Pont trade-mark for its tetrafluoroethylene resin*

Rubber Covered Rolls | Sintered Metal Friction Elements | Asbestos Textiles | Teflon Tape, Packings, Sheets, Rods, Tubes

AND TEFLON PRODUCTS

MECHANICAL RUBBER PRODUCTS

Manhattan Rubber Division
Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

PACKINGS, GASKETS, ASBESTOS TEXTILES AND TEFLON PRODUCTS

Packing Division or
Asbestos Textile Division
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

FRICTION MATERIALS

Equipment Sales Division
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Neenah, Wis. • Manheim, Pa. Bridgeport, Conn. • No. Charleston, S.C. • Crawfordsville, Ind. • Peterborough, Ontario, Can.

Manufacturers of Mechanical Rubber Products • Packings • Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products Fan Belts • Radiator Hose • Rubber Covered Equipment • Asbestos Textiles • Teflon Products • Abrasive and Diamond Wheels • Bowling Balls

R/M

Compact...

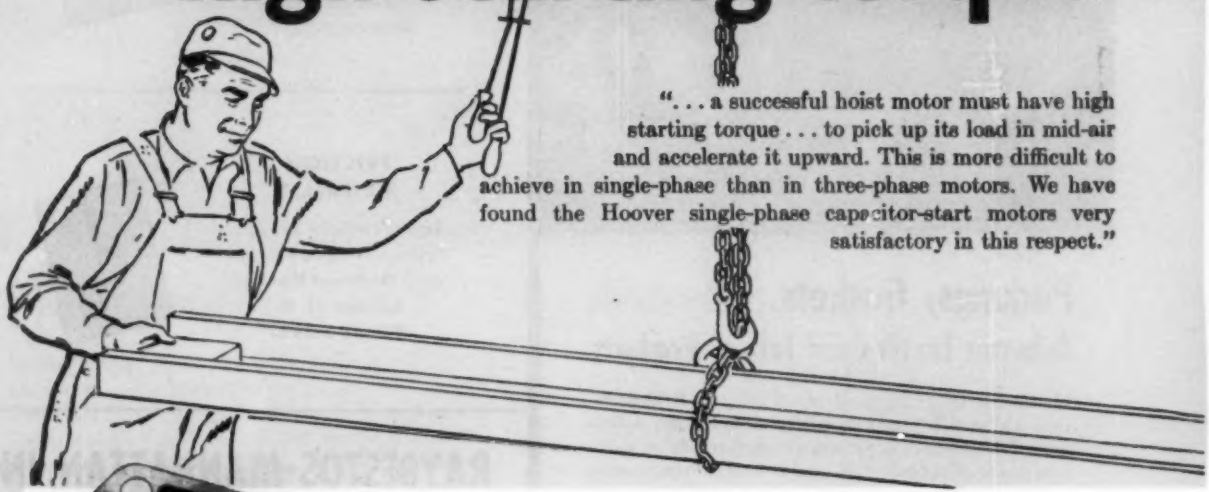
"One of the principal requirements for the motor of a small hoist is that it must be of minimum diameter because this affects the depth of the hoist and, therefore, the height to which the hook may be raised."

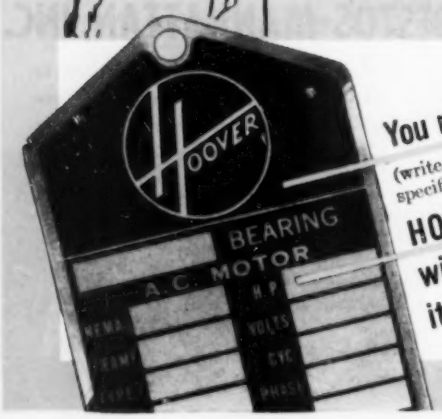
Cool-running...

"For top quality performance in a hoist it is necessary to use totally enclosed motors . . . We have found that Hoover totally enclosed hoist motors do not overheat even in severe service."

High starting torque....

". . . a successful hoist motor must have high starting torque . . . to pick up its load in mid-air and accelerate it upward. This is more difficult to achieve in single-phase than in three-phase motors. We have found the Hoover single-phase capacitor-start motors very satisfactory in this respect."

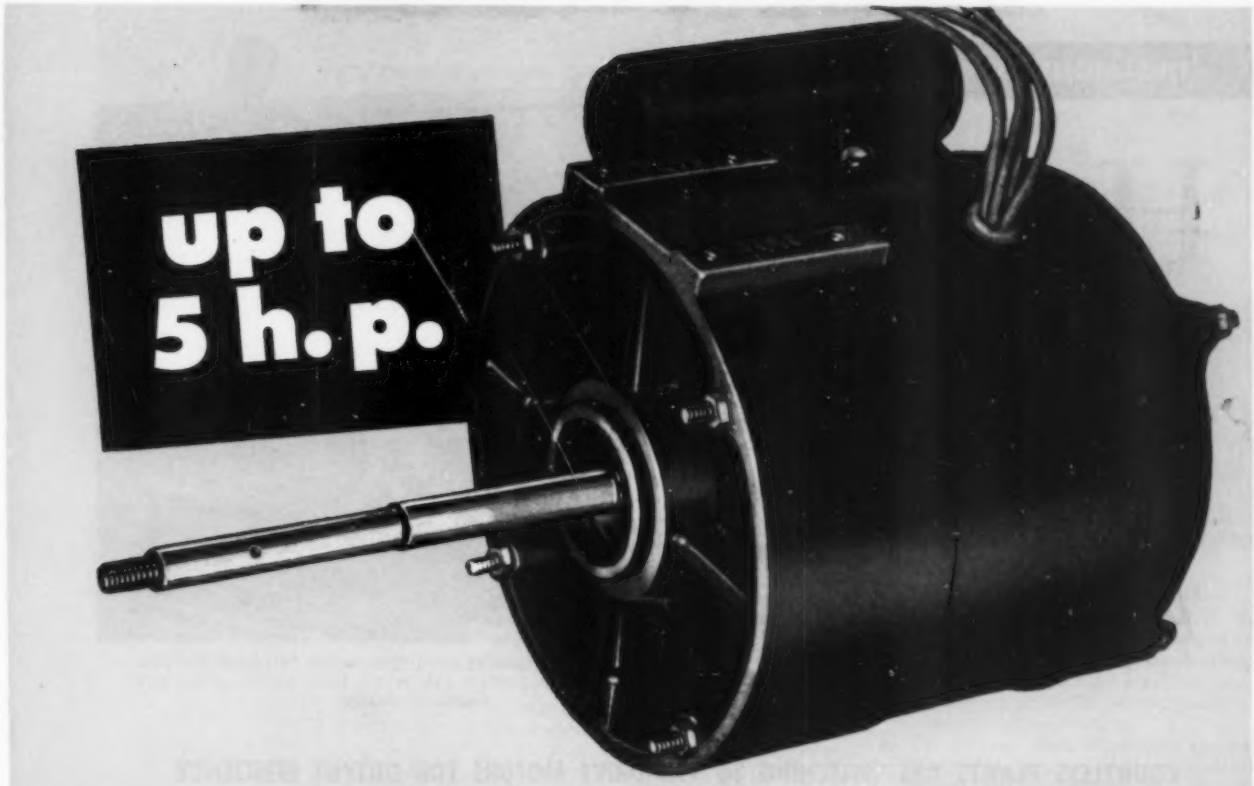




You name it... (write your own specifications) **HOOVER will deliver it.**

Whether you need a motor for new equipment, or as a replacement, you are almost certain to find exactly what you want in the current Hoover catalog. Hoover in-production Electric Motors come in a wide and complete range of models with ratings up to 5 h.p.

Should you need motors with special mechanical or electrical characteristics, look again to Hoover. Hoover engineers will gladly work with your own engineering department to come up with a motor tailor-made for your job.



.....that's why Chisholm-Moore Hoist Division use

HOOVER

Electric Motors

in their famous Comet Hoists

Whether it's "in-production" or "customer-tailored," every Hoover motor is fully guaranteed by The Hoover Company. And Hoover's world-wide service organization assures you of prompt maintenance and long, trouble-free operation.

Let us suggest how we may help you with your own motor problems. Mail the coupon today (no obligation, of course).

PRODUCTION FOR HOME AND DEFENSE—Week in and week out, Hoover is producing a very substantial volume of essential materials for the Armed Forces.

THE HOOVER COMPANY
ELECTRIC MOTOR DIVISION
83 BROOK AVENUE, NORTH PLAINFIELD, N. J.

Please send me further information on Hoover Motors. I am particularly interested in motors for

_____
(indicate type of equipment)

Name_____

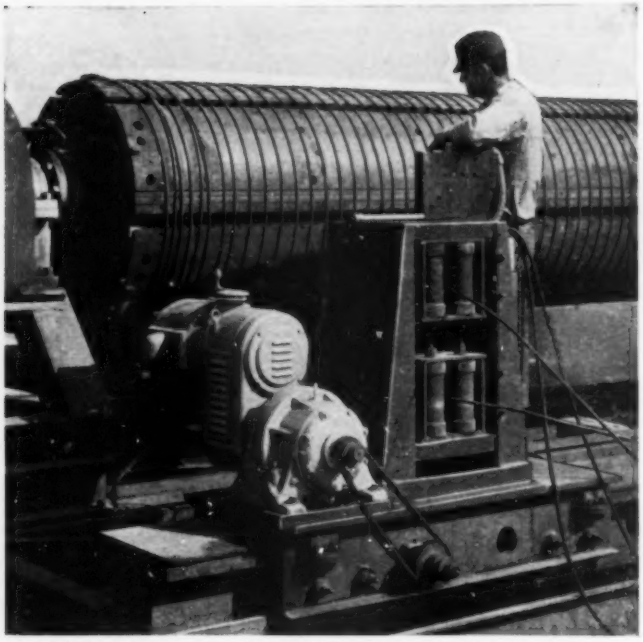
Company_____

Address_____

City_____ Zone_____ State_____

THIS MONTH'S MOTOR TIPS

How Variable Speeds *improve production tempo*



U. S. Varidrive motor operating special drum machine for fabricating circular reinforcing cages for concrete pipe; permits speed variation to suit each diameter of wrapping.

COUNTLESS PLANTS ARE SWITCHING TO VARIDRIVE MOTORS FOR OUTPUT EFFICIENCY

MAKING machines more responsive to the operator's command has resulted in an amazing step-up in production. Machines powered with conventional constant-speed motors "loaf on the job" during many operations, but the same machines driven with Varidrive motors can accomplish one or a combination of these improvements—(1) increase production by the adjustable "overdrive" of accelerated speed; (2) effect better cutting or operating action by setting speed at the precise rpm essential for the job; (3) provide the operator with infinite speeds to coordinate with his rhythm of movement or selection of speed that is, in his judgment, just the exact rpm to produce his best workmanship.

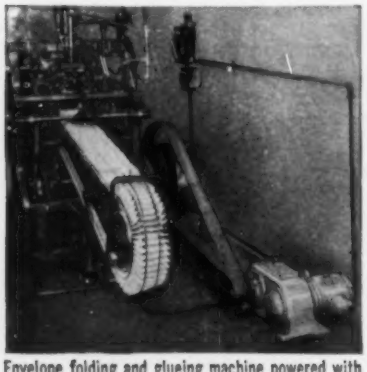
Just as an automotive engine operates at highest efficiency at a certain speed, almost any production machine or powered equipment will produce more where selectivity of motor speeds is provided. In a study of advantages created by the use of variable speeds, the manufacturers of U. S. Varidrive motors have compiled a list of applications covering diversified fields ranging from sewing machine factories to sorghum mills. From most of these interesting applications the design engineer and plant production engineer can learn of uses they can apply to their own sphere of operations.

NO GUESSING OF MOTOR SPEED

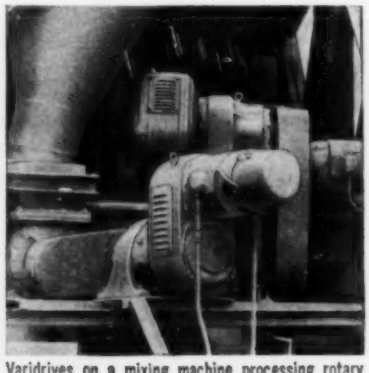
For instance, the design engineer doesn't have to try to guess what the ultimate speed factor will be in order to be sure his machine will deliver the full optimum of production *after* installation. By installing a Varidrive motor he endows his product with speeds instead of a speed; consequently in service his machine presents an "ableness" to adapt itself to a wide range of conditions far beyond his contemplation. If a fixed speed motor operates the machine the design engineer might have guessed wrongly the speed to give it.

REMOVING RESTRICTIONS OF SPEED

The plant production engineer need not be restricted to a set operating speed of a machine. He can, with the Varidrive, experiment with speeds to do a specific job best. For example, a conveyor may at times, when heavily loaded, require slow speed, then higher speed when the load is light, or when parts have to get to a worker's location



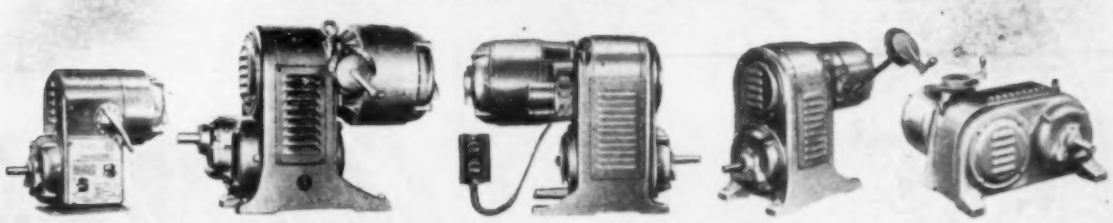
Envelope folding and glueing machine powered with U. S. Varidrive. For different sizes of envelope a different speed is required.



Varidrives on a mixing machine processing rotary drilling oil base. The proper mix depends on the exact speed required to blend materials.

Conveyor travel is controlled for better distribution and timing with a Varidrive. This conveyor is an automatic system for drying printed material.

TYPICAL VARIDRIVE MOTOR TYPES



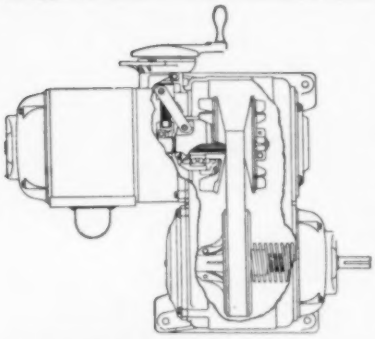
TYPE VA—SMALL H.P.
Low cost model, ¼ to ¾ h.p. 4 to 10,000 rpm. Ratios 10:1. 1 & 3-phase.

TYPE VEU—GH
Upright case with low shaft. Control dial on side.

ELECTRIC CONTROL
Varidrive with Type ERC heavy-duty remote control motor.

REMOTE CONTROL
One of many control arrangements. Control shaft can be extended.

TYPE VE
Horizontal case with control dial on top of motor.



OPERATION OF A VARIDRIVE

By turning control dial, the diameters of the belt discs expand or contract, thus changing fixed speed of motor shaft to variable speed of the take-off shaft. Quiet, shockless, enclosed transmission.

faster. In cutting shafts on a lathe from large to small diameter, frequent change in speed keeps the power tool operating at a uniform lineal travel to get the job completed in the least time. With a Varidrive, the speed can be instantly changed to synchronize with each specific travel or load condition.

Machines turning out different sizes of parts can produce better with variable speeds. If work chatters, feed can be adjusted for best surface speed, longer tool life and finer workmanship.

In experimental processes involving mixing in vats under varying conditions of viscosity, temperature, homogenization or rate of agitation, variable speed plays an important role, which is impossible with a fixed speed motor. The right speed makes all the difference in getting the right mix. With Varidrive no step-cone pulleys, external gears, intermediate speed changers or connections, such as extra chains and couplings are needed. Usually a Varidrive can be direct connected to the prime driving shaft of the machine or equipment.

In pumping and hydraulic control operations variable speed is the answer. Flow, pressure, suction and load can be maintained at just the right equilibrium by a Varidrive. In some machines the exasperating problems of noise, chatter, vibration, over-heating and pulsation contribute to the shortened life of equipment, or affect the quality of the product undergoing processing. These troubles can be invariably "cured" with a Varidrive because the operator can experiment down to a split rpm to get the most sensitive speed to overcome the trouble.

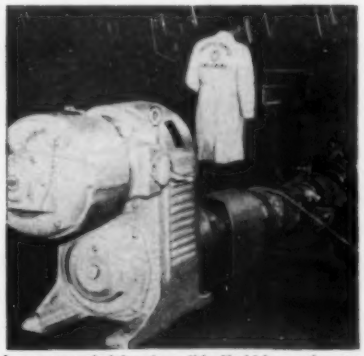
SPEEDS TO FIT TIMING FACTORS

Equipment is frequently required to complete an operation in predetermined time. Variable speed permits a step-up or step-down to establish the right production tempo. In controlling cycles of infra-red baking, drying, heating, soaking, grinding, capping, tumbling, coating, plating, etc., speed movement must be precise—or rejects will cut into profits. What, then, is more logical than to install a Varidrive to provide the nerve-center of speed regulations?

IMPROVEMENT IN OUTPUT

In thousands of plants, the U. S. Varidrive motor has brought about amazing improvements in production. Powered machines have had their output stepped up to 30 percent or more in innumerable instances.

In general, these Varidrives can be obtained in a range of from ¼ to 50 h.p., and for speeds from 2 to 10,000 rpm in ratios of 10:1.



In a research laboratory this Varidrive motor operates test equipment for checking performance characteristics of water pumps.

This combination U. S. Varidrive-Syncrogear powers a special roll grinding machine for cold rolling aluminum sheets, from heavy to light gauge.

ADVERTISEMENT

16-Page Motor Booklet

Free

72 Pictures
22 Models

Tells all about

U. S. VARIDRIVE MOTORS

Mail the Coupon

Request for Varidrive Booklet

U. S. ELECTRICAL MOTORS Inc. PE-10
Box 2058, Los Angeles 54, Calif., or Milford, Conn.

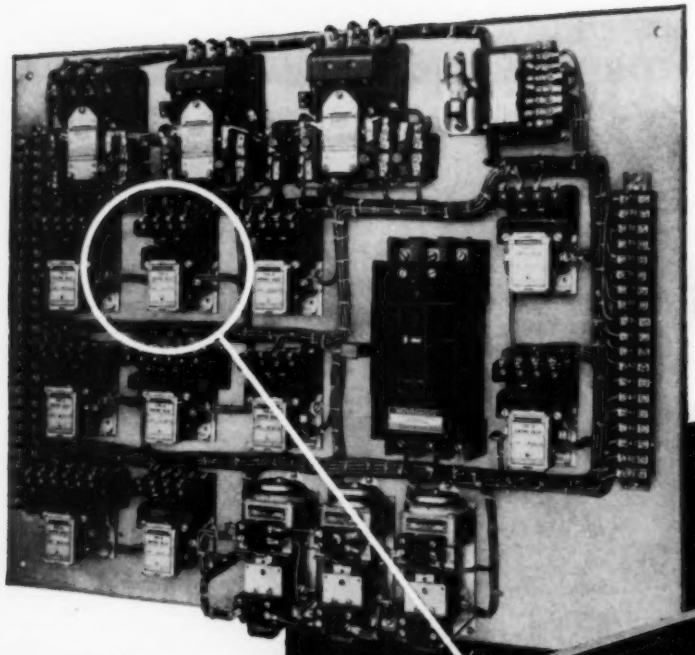
Send free 16-page Booklet. No obligation

NAME_____

COMPANY_____

ADDRESS_____

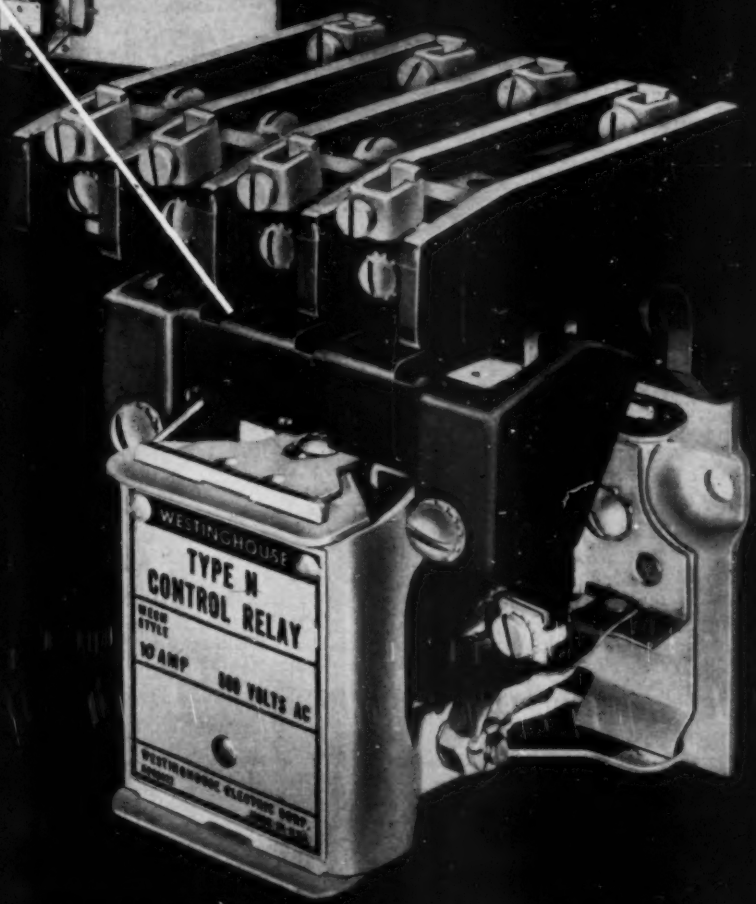
CITY_____ ZONE___ STATE___



Typical special control panel with all Westinghouse components.

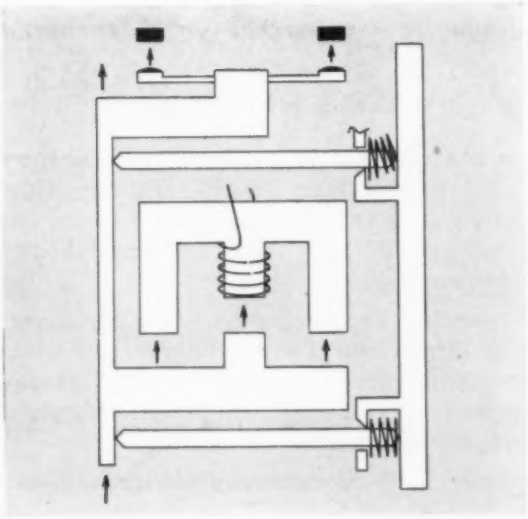
Compare...

New Westinghouse
Type N Control Relay

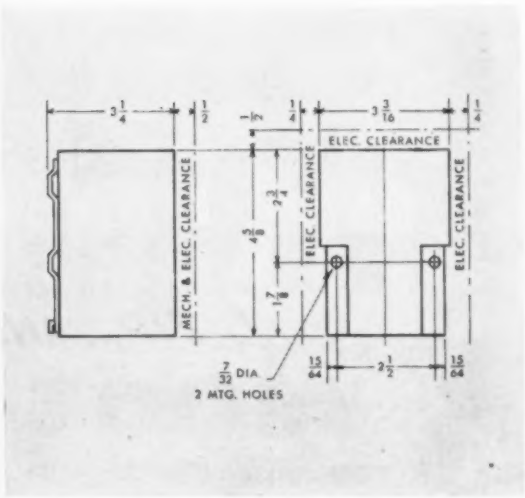


Compare the Westinghouse complete control line for any application

Westinghouse control relays



Contact assembly is pulled against a stationary magnet—rides on two friction-free knife-edge bearings. Eliminates sticking and jamming experienced with guided plunger or armature type of relays.



Type N Control Relay is rated 10 amperes (open). Up to 600 volts. Up to 6 poles. Available open or in standard NEMA enclosures. Dimensions for 2 & 4 pole shown above.

floating action on friction-free knife-edges eliminates sticking, jamming

Reduce friction to a minimum and you eliminate a control relay headache. That's what Westinghouse engineers did in designing the new Type N Relays—and it means new performance standards for your control panels.

Unlike conventional designs, the Type N's moving armature literally floats on two knife-edge bearings. This exclusive Westinghouse design is virtually friction free—cannot stick or jam—greatly extends relay life. In addition, a positive-action kickout spring makes rapid operation possible, since it does not depend on gravity alone.

Type N Relays are versatile—ideal for pilot circuits, automatic control and sequencing operations. They are compact—save critical mounting space. They are convenient—all parts are easily accessible and front-removable. They are flexible—change contacts from NO to NC in the field easily, without disconnecting any wires.

The Type N Relay is typical of the complete line of Westinghouse control equipment. Starters, contactors, timers, circuit breakers, transformers, disconnects, relays—*every* Westinghouse control is better engineered to better your machines and give you more customer satisfaction.

For complete information and application assistance on Type N Relays and other Westinghouse control equipment, call your Westinghouse Representative, or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-30151

YOU CAN BE SURE...IF IT'S Westinghouse

Drop that Soldering

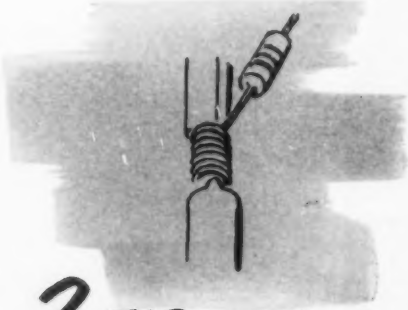
Revolutionary new method wraps connections so tightly that soldering is unnecessary

Here is a method that produces electrical connections more reliable than the most skillfully soldered connections . . . in a fraction of the time . . . at a fraction of the cost. Operator training takes only minutes instead of days.

By replacing hand operations with pneumatic or electric Wire-Wrap Tools, you get consistently uniform connections all through the day. Rejects are greatly reduced . . . inspection becomes simple . . . production costs are cut.

Investigate this revolutionary new process—write for Bulletin No. 11, today.

1 INSERT WIRE



2 ZIP... AND

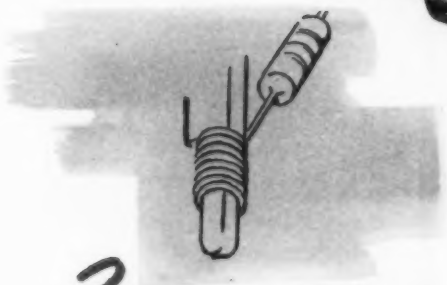
Wire-Wrap Tools

are now available from Keller—
the original manufacturer

Iron, Sister!!...

THIS **NEW**
Wire-Wrap Tool
MAKES SOLDERLESS CONNECTIONS
...in half the time!

Manufactured under patent license agreement with Western Electric Company Incorporated



3 IT'S FASTENED

KELLER
Wire-Wrap
TOOLS
Wire-Wrap Division
KELLER TOOL CO.
Grand Haven, Michigan

In products like these...

When Schatz can save you

up to 6 to 1

why pay for unneeded precision in ball bearings?

When Schatz can save you

up to 6 to 1

why pay for unneeded precision in ball bearings?

When Schatz can save you

up to 6 to 1

why pay for unneeded precision in ball bearings?

When Schatz can save you

up to 6 to 1

why pay for unneeded precision in ball bearings?

SCHATZ
"Commercial"
BALL BEARINGS

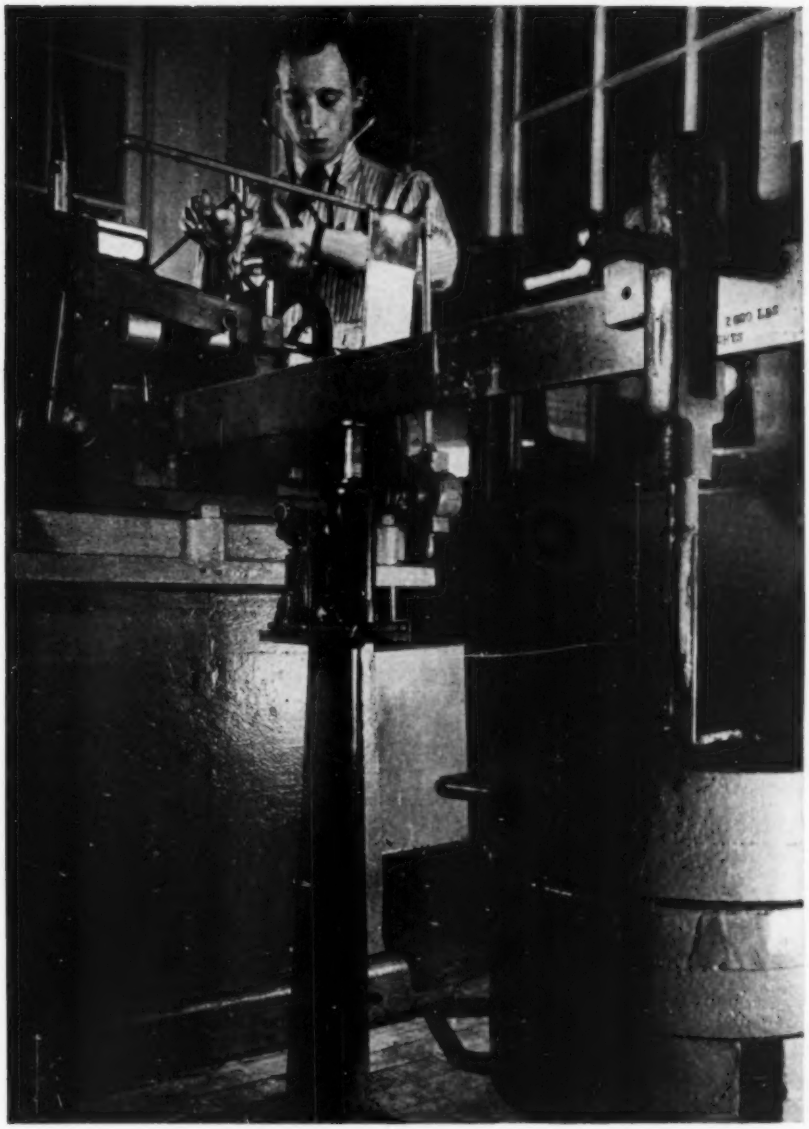
Want more information?

Want to learn how you, too, can save up to 6 to 1 in bearing applications where speeds and loads are moderate? Schatz Catalog No. 11 lists over 1000 types, tells how and where you can apply the commercial bearing principle.

Write today for:

1. Schatz Catalog No. 11.
2. Technical Bulletin—tells how to determine proper size "Commercial" Ball Bearing for various speeds and loads.

The **SCHATZ** Manufacturing Co., 6758 Fairview Ave:, Poughkeepsie, N. Y.



Failure is his business

and it makes ours a success

When we design a new ball bearing at Federal, one of our project engineers works out its estimated life under the specified speeds and loads. But this is on paper only, and that's not proof enough.

So the next step is to have a prototype bearing constructed by hand. It is placed in a machine like the one above, put under load, and run until it fails. These prototype bearings are made again and again and tested in this way until we are satisfied with the findings.

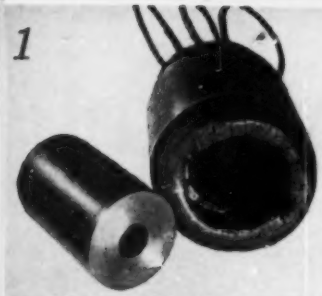
But, when the tests are finished, we *know* exactly what a bearing will do. That's why you can be *sure* of top performance from every Federal Ball Bearing.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal
Ball Bearings

One of America's Leading Ball Bearing Manufacturers

1



R & M Polyphase motor parts, consisting of rotor and stator, horizontal position. Light weight and reserve power for heavy duty use were the most important motor characteristics required.

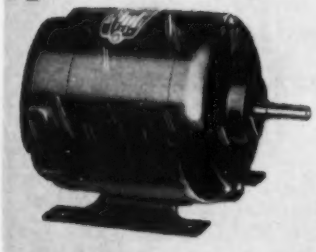
2

This motor had to be lightweight, powerful and capable of running for long periods at 36,000 R.P.M. It's dynamically balanced with a diamond-turned commutator and specially anchored windings.

3

This powerful R & M Motor has a high starting torque for quick response; it runs cooler than normal, it's exceptionally quiet, and it's *compact*. Extra-heavily insulated, dynamically balanced, 100% inspected.

4

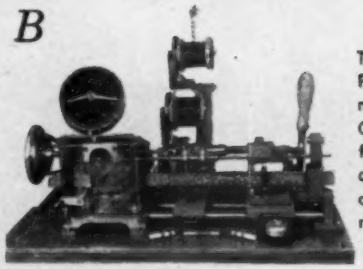


Variable speed was a must for this R & M Motor—to permit a wide selection of speeds without need for changing belts or pulleys. Motor is ¼ HP, AC-DC 5000 R.P.M., ball bearing equipped and open ventilated.

A

The ultra-high-speed SKIL Grinder, made by Skil Corporation, packs twice the power per pound of other grinders of similar weight. Tool and die makers say it's great!

B



The Geo. Stevens Model 125 Progressive Universal Winder made by Geo. Stevens Mfg. Co., Inc., world's largest manufacturer of coil-winding machines. One of a complete line of R & M Motor-equipped machines.

C

The powerful, easy-to-handle Buckeye Hi-Frequency Sander. It's ideal for automotive and industrial applications where tools are subjected to continuous, heavy duty service. R & M furnishes motors to Buckeye Tools Corporation in capacities from 3/16 to 4 HP.

D

The IBM Executive made by International Business Machines Corp., the only typewriter manufacturer exclusively producing electric machines. It's the mark of a modern office!

Can YOU match these motors to these tools and machines?

Here are some R & M fractional horsepower motors, and the machines for which they were selected or designed. Can you guess which goes with which? The answers are printed at the right . . . what was *your* score?

THE ANSWERS

R & M motors and motor parts, and the machines on which they are specified as standard, match up as follows:

1-C 2-A 3-D 4-B

ON COMPLETE MOTORS OR MOTOR PARTS . . .

Don't "guess" . . . let Robbins & Myers do a *scientific* job of matching the all-important motor to your product! Regardless of whether you need a motor that's standard or custom-designed . . . motors with special housing designs or motor parts to fit your housings, remember that R & M Motors are powering all types of equipment, such as . . . . . .

Portable Saws
Drills
Nut Setters
Hammers
Routers
Screw Drivers
Hedge Trimmers
Lawn Mowers
Nibblers
Lock Mortisers
Valve Grinders
Vacuum Cleaners
Files
Sanders
Pumps
Compressors
Hones
Business Machines
Cast Cutters
Food Mixers
Polishers
Planers
Portable Grinders
Sirens
Hair Driers
Advertising Devices
Ventilating Equipment
Oil Burners
Surgical Instruments
Grease Guns
Vibrators
Die Sinkers
Waxers

why you get better performance from a Fractional Horsepower Motor that's matched to your machine!

The most important single factor in the performance of any motor-driven product is the *motor itself*. That's why the engineers who designed the well-known tools and machines at the left came to Robbins & Myers to get the *right motor for the job.* Like many other R & M customers, they knew that the motor which met *every requirement*—one by one—was bound to improve the performance of their products, and *last longer* as well.

Selecting such a motor isn't simple. You can, of course, *look* at these examples, and try matching the motor to the machine for which it was designed. It's easy to guess, but in your business you can't afford guesswork.

Neither can we. That's why we've set up such systematic methods for designing motors. For example, we often use the R & M "Electrical Slide Rule." In this unique machine we first set up the electrical equivalents of motor *operating conditions;* then test equivalents of various motor *designs.* Result? Required motor characteristics can be calculated in minutes instead of days!

In some cases, the answers point to a standard motor. We have many such motors to choose from. But in other cases where special motors are indicated, we can do a fast, thorough, economical job of custom-designing a motor that's *exactly right* for your product.

In short, our experience—and our approach to your problem—isn't limited to standard motors we have "on the shelf."

If you feel that the motors you're now using aren't 100% right—in quality or in performance characteristics—we can make a real contribution to the solution of your problem. Use the coupon below . . . you will get the information you want promptly.

if it's an R&M it's the Right Motor!

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

ROBBINS & MYERS, INC., MOTOR DIVISION, SPRINGFIELD 99, OHIO: PD-103

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

Name _____ *Title* _____

Company _____

Street _____

City & State _____

What's Screwy? by Phillips

"Ed has discovered that Phillips Cross-Recessed-Head Screws are definitely decorative."

PERFECTLY MATED! Only Phillips Drivers are perfectly mated to Phillips Screws. Look for the name Phillips on the shank.

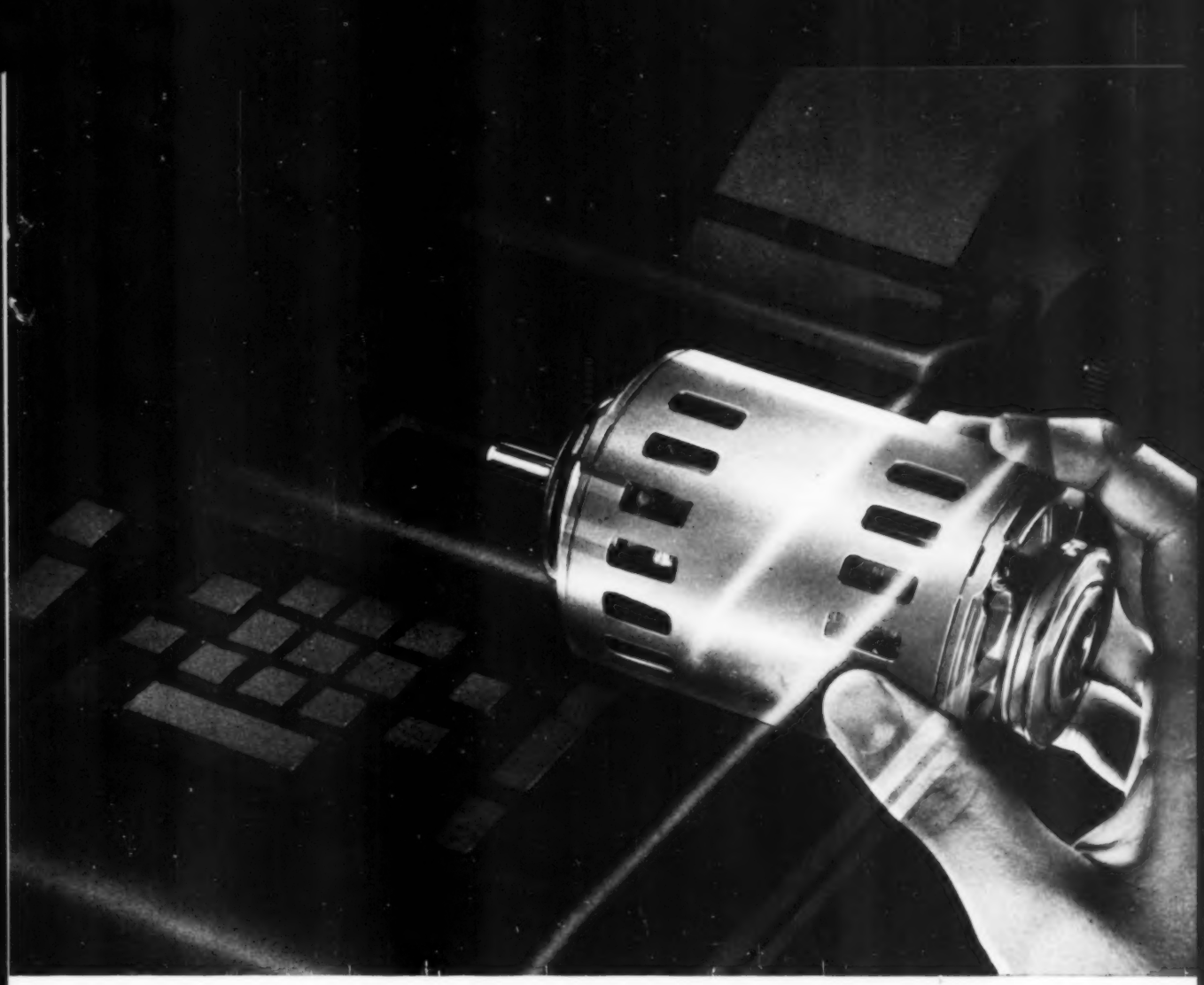
DECORATIVE APPEARANCE is but one of many advantages of Phillips Screws. They cut driving time up to 50%, eliminate driver skids and split screw heads. These screws add structural strength, set up tighter, resist vibration. To save time, work, money insist on Phillips Screws — Wood, Machine, Tapping Screws or "Sems."

PHILLIPS *Cross-Recessed-Head* SCREWS

X marks the spot... the mark of extra quality

AMERICAN SCREW COMPANY • ATLANTIC SCREW WORKS, INC. • THE BLAKE & JOHNSON CO.
CENTRAL SCREW COMPANY • CONTINENTAL SCREW COMPANY • THE EAGLE LOCK COMPANY
ELCO TOOL AND SCREW CORPORATION • GREAT LAKES SCREW CORPORATION • THE H. M. HARPER CO.
THE LAMSON & SESSIONS COMPANY • NATIONAL LOCK COMPANY
THE NATIONAL SCREW & MANUFACTURING CO. • PARKER-KALON CORPORATION
PHEOLL MANUFACTURING CO. • ROCKFORD SCREW PRODUCTS CO. • SCOVILL MANUFACTURING CO.
SHAKEPROOF DIV. OF ILLINOIS TOOL WORKS • THE SOUTHINGTON HDWE. MFG. COMPANY
STERLING BOLT COMPANY • STRONGHOLD SCREW PRODUCTS, INC. • WALES-BEECH CORP.

TODAY'S... AND THE FUTURE'S... FINEST FASTENER



Your product can be smaller, quieter with new miniature G-E induction motor

Ninety-five percent of all business machines can use this new and revolutionary G-E miniature motor.

The business machine industry demands a constant-speed motor that is small, quiet, free of radio interference. G-E Specialty Motor engineers in Fort Wayne Ind. have designed this new 49-frame motor with only a 3-inch diameter . . . noiseless within ordinary ear range . . . no radio interference . . . and a constant speed.

While this miniature motor was designed for a specific industry, it has unlimited applications such as . . . movie projectors, communications equipment, dispensing machines, etc. Maybe you have a design problem this motor can solve.

For full information, contact your nearby G-E Apparatus Sales Office. Turn the page for an example of designing assistance available to you at General Electric.

You can put your confidence in—

GENERAL ELECTRIC

Need motor application help?

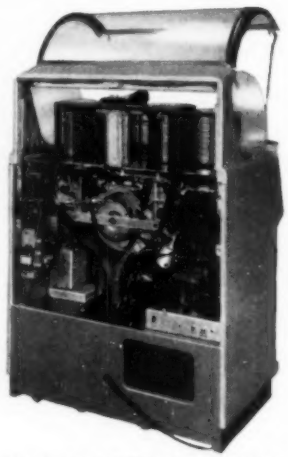
The Wurlitzer story shows why it pays to

Get motor application help from G-E Engineers . . .

Here is a designing problem that was solved by the G-E Specialty Motor Department at Ft. Wayne. The Rudolph Wurlitzer Co., North Tonawanda, N. Y. recently redesigned their coin-operated record player to handle fifty-six more recorded selections and play all three speeds. To simplify the mechanical operation of the machine, they replaced one gear-motor with two smaller gear-motors. G.E. was asked to design the series-motor parts for these gear-motors with the necessary electrical characteristics.

Working closely with the customer's design engineers . . . G.E. not only solved the problem but gave the customer motor parts which exceeded the specifications as the story below shows.

When you have a motor design problem take advantage of G-E engineering skill and talent backed by years of experience. Contact your nearby G-E Apparatus Sales Office.



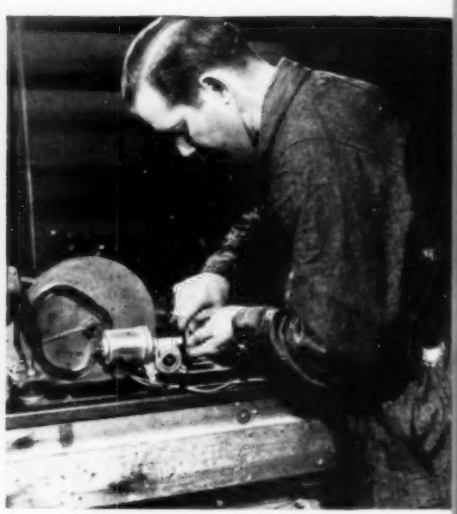
NEW WURLITZER MACHINE plays 104 selections at all three speeds. G-E engineers solved series-motor parts problem.

You can put your confidence in—

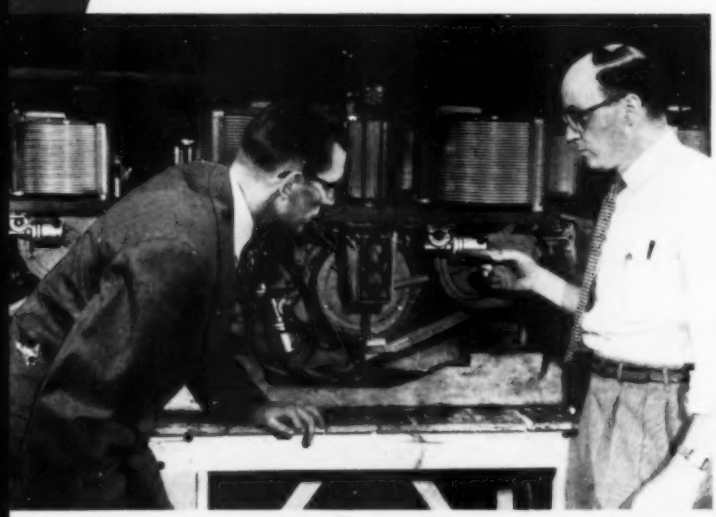
GENERAL ELECTRIC

REQUIREMENTS of motor parts to drive record changer in new machine are discussed by G-E motor specialist and Wurlitzer design engineer.

TESTING of sample parts designed by G-E Specialty Motor engineers showed that the motor parts met the precise electrical requirements of the Wurlitzer machine.

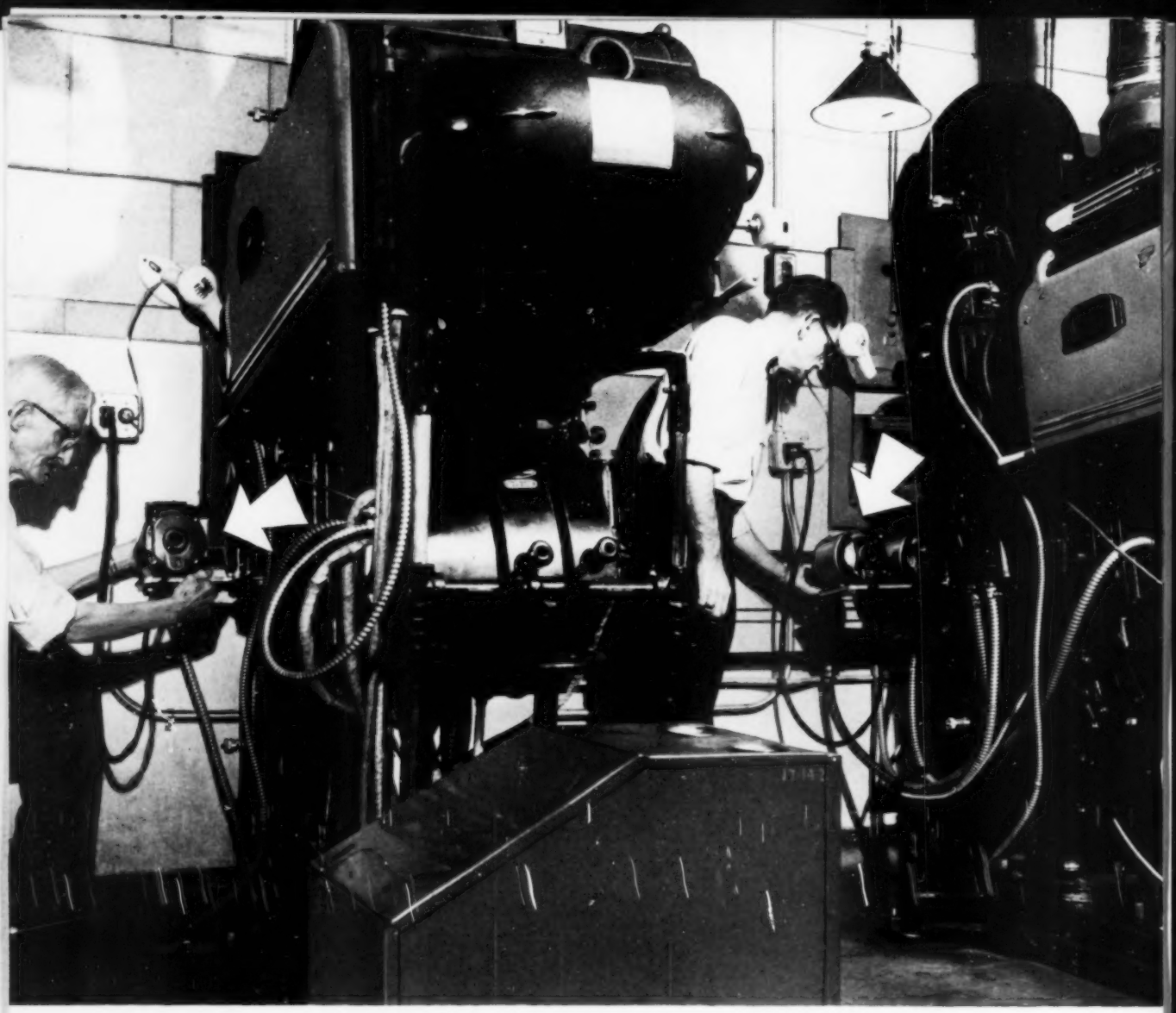


INSTALLATION of two gear-motors using specially designed G-E series-motor parts in Wurlitzer machine which plays 104 selections at all three speeds.



COMPLETED record player using two fhp gear motors with G-E designed parts. G.E. continued research and gave customer parts with electrical characteristics exceeding original requirements.

How 3 D's "brains" can help you



Versatile G-E Selsyns are "3 D's" brains precisely synchronize two projectors

A flick of a switch, and 2 movie projectors start running in exact unison for stereoscopic pictures — thanks to precise control by G-E selsyns. Shown above are two standard selsyn-generators, each linked to a projector by a short chain and sprocket. Plugged into a standard wall outlet, the selsyns are interconnected by three wires.

If one projector moves faster than the other, an abnormal current flows between the selsyns, creating a torque which instantly slows down the faster selsyn and speeds up the slower.

This simplicity, plus economy and long life, makes G-E selsyns ideal for accurate signal, control, or indication systems. G-E selsyns require virtually no maintenance, and are easily and inexpensively installed. No special training is needed to operate them. Accuracy is maintained indefinitely and they last so long that a G-E selsyn system installed in 1914 in the Panama Canal locks is operating efficiently today. Find out more about these G-E selsyns. See your nearest G-E Apparatus Sales Office or write for Bulletin GEA-2176C to Section 704-8, General Electric Co., Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

NATIONAL OIL SEAL LOGBOOK

Write our Redwood City office for reprints of this Logbook page

Sealing News & Tips

How Dart uses National O-Rings in front end suspension of 60-ton truck

Among the many unusual features of the new Dart 60-ton dump truck is the air-hydraulic suspension system for the front axle.

As the dual 18.00 x 25 tires roll into a depression, the fixed piston (Figure 2) moves downward. This forces S.A.E. #30 mineral oil from the piston chamber to the hollow piston and compresses captive air above the oil level. As the truck's weight presses downward, the operation is reversed. In both cases, counter-pressure between air and oil absorbs road shocks.

To insure zero leakage sealing in this demanding application, four National O-Rings are employed. Three O-Rings seal various piston or cylinder parts, and a fourth seals the oil intake valve. O-Ring diameters range from approximately 16" on the piston cap to 1" on the intake valve. O-Rings are all conventional National synthetic rubber O-Rings, designed to withstand temperatures up to 300° F and pressures to 1,500 p.s.i.

Figure 1. Dart Model 60 Truck

Standard-design National Oil Seals with single and dual spring-tensioned sealing lips (Figure 3) are also utilized in the truck—particularly in the wheel bearing assembly, planetary clutches and twin 350-horsepower engines.

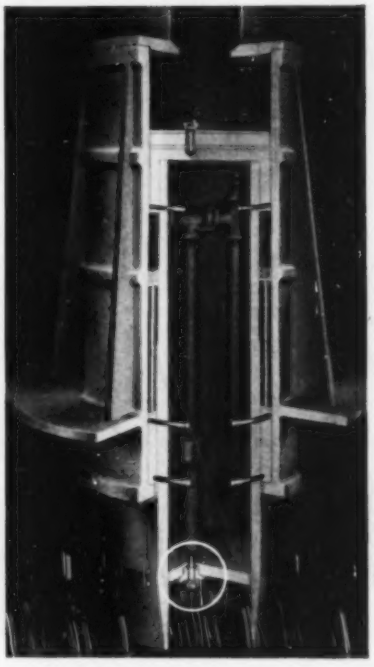
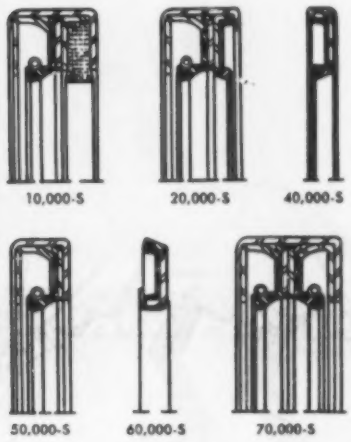


Figure 2. Dart Front End Suspension Unit

Precision-made National Oil Seals and O-Rings are available in thousands of standard types and sizes. If conventional units do not precisely suit your application, modified or special seals can be designed. Call the factory-trained National Applications Engineer nearest you for complete information.

Figure 3. National 50,000 (left) and 10,000 spring-tensioned leather oil seals

Standard-design National Syntech* Oil Seals are widely used for zero leakage operation in applications where intermittent temperatures reach 300° F, speeds reach 3,600 F.P.M., and total indicator runout reaches .030. These basic designs employ tough, accurately manufactured steel outer cases, precision-tensioned springs and accurately molded and trimmed Syntech sealing lips unaffected by water, most lubricants, detergents or industrial fluids.



"Let Your Decision be Based on Precision"

NATIONAL OIL & GREASE SEALS O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

*T. M. Reg.

2814

CALL IN A NATIONAL APPLICATIONS ENGINEER

CHICAGO, ILL. . . . *Room 4113 Field Building, FRanklin 2-2847*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, TRinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF. . . *Broadway and National, EMerson 6-3861*
WICHITA, KANSAS . . . . *519 South Broadway, WIchita 2-6971*

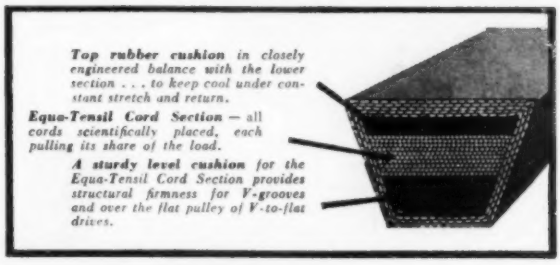
Tailored for something SPECIAL...

U. S. RAINBOW® V-BELTS

Why U. S. Rainbow V-Belts are superior:

If a belt has to handle conditions not found on the average drive, then U. S. Rubber engineers custom-build it for the job. You can order a special U. S. Rainbow V-Belt to handle *any* operating conditions, such as oil, high temperatures, and static electricity.

Remember that U. S. Rainbow V-Belts have a unique Equa-Tensil Cord Section—an exclusive process which provides efficient pull and strength under the most adverse conditions. Order from your jobber, or contact any of our 25 District Sales Offices, or write to address below.


Top rubber cushion in closely engineered balance with the lower section . . . to keep cool under constant stretch and return.
Equa-Tensil Cord Section — all cords scientifically placed, each pulling its share of the load.
A sturdy level cushion for the Equa-Tensil Cord Section provides structural firmness for V-grooves and over the flat pulley of V-to-flat drives.

A COMPLETE DRIVE SERVICE

MULTIPLE V-BELTS • F.H.P. V-BELTS • SHEAVES
FLAT BELTS AND BELTING • SPECIAL PURPOSE BELTS

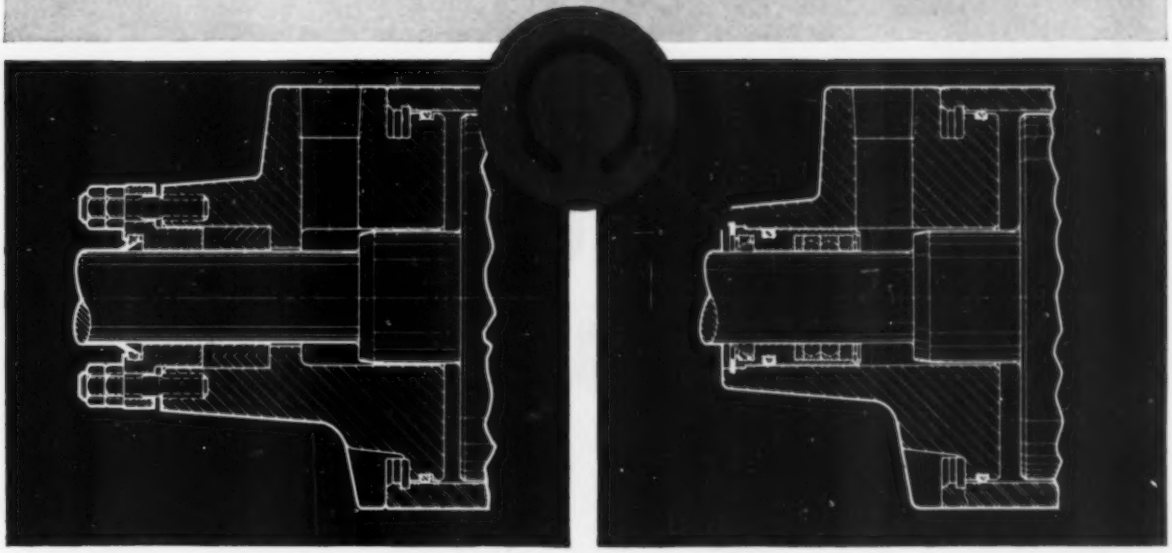
U.S. RUBBER
SERVING THROUGH SCIENCE

"U.S." Research perfects it.
"U.S." Production builds it.
U.S. Industry depends on it.

UNITED STATES RUBBER COMPANY
MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

Waldes Truarc Ring Saves $2.84 Per Unit, Cuts Labor-Time and Materials in Hydraulic Packing Unit



OLD STYLE stuffing box required skilled worker to install packing rings one at a time, then adjust packing glands by trial and error. Disassembly was equally difficult, time-consuming and costly.

NEW Monopak Cartridge is smaller, lighter, streamlined and installed with one Truarc Retaining Ring. Disassembly and reassembly with new cartridge takes unskilled worker just 1 minute.

Hydraulic Accessories Company of Van Dyke, Michigan, uses a single Waldes Truarc Inverted Ring (internal series 5008) to hold Monopak Cartridge in cylinder head.

New design eliminates costly machining and saves 2⅛ lbs. of material. Re-design with Waldes Truarc Retaining Ring reduces stuffing box diameter from 3½" to 2⅞", and reduces length from 5⅞" to 4⅜". Allows savings in assembly, adjusting and testing.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS PER UNIT

MACHINE TIME SAVED:	
Chucking, facing and boring	$ .72
Drilling and tapping 3 holes	.18
Drilling and counterboring 3 holes	.12
Assembling, adjusting, testing	.90
MATERIAL SAVED:	
1⅛ lbs. cast iron	.30
⅛ lb. bronze	.23
3 studs	.36
3 nuts	.03
TOTAL	**$2.84**

Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool.

SEND FOR NEW CATALOG

WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,410,853; 2,430,921; 2,438,341; 2,439,705; 2,441,845; 2,455,165; 2,483,380; 2,483,382; 2,487,802; 2,487,803; 2,491,306; 2,509,981 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print) PN-105

Name.....

Title.....

Company.....

Business Address.....

City..... Zone..... State.....

★

here is your complete

"aluminum component production department"

ALSO MAKERS OF
MIRRO
The Finest Aluminum
Cooking Utensils

Four Large Fabricating Plants and Rolling Mill
1,600,000 sq. ft. present floor space. Additional facilities under construction.

Spacious Aluminum Rolling Mill

Complete Die-Making Facilities

Wide Range of Stamping Presses

Heat Treating Equipment

• Have you been wondering about your aluminum component problem? You may not have realized that *you already have a complete aluminum component production line, installed, equipped, staffed, and seasoned in your kind of work, located right in Manitowoc, Wis.*

More than half a century of working with aluminum qualifies us to "join your organization" for the mutual solution of your individual problems, then to feed a flow of parts into your assembly line that will be as accurately made and dependably timed as any other division of your present operation.

A letter, wire, or phone call will bring a trained consultant to your plant, to discuss your specific requirements, whether they be research and development, production and delivery, or all four of these. Let's have that talk soon, so that we can dovetail our schedules into your own and fit your "new department" smoothly and efficiently into your present organization.

CONTRACT DIVISION

ALUMINUM GOODS MANUFACTURING CO.

MANITOWOC, WISCONSIN

Fifth Avenue Bldg., New York 10 • Merchandise Mart, Chicago 54

Metallurgical Laboratory

Chemical Laboratory

Designing Staff

Engineering Department

Welding—Gas and Electric

Complete Finishing Facilities

Before you tool up... investigate the services you get from

Kirksite*

Proved-Performance Tooling

Are you planning to produce a new model or a new product of sheet metal?

Then it will pay you to look into the Kirksite Tooling Service.

The Kirksite Tooling Service consists of pattern making, die and punch casting, die finishing, press proving of dies, and stamping, forming and finishing of actual sheet metal parts... all in the same shop. All with undivided responsibility.

Sheet metal products manufacturers say it's an ideal service to eliminate their tooling-up problems, also permits extensive design changes, if necessary, before production runs are started.

So, if you have planes, trucks, cars, household appliances, even dust pans and ash trays... or almost anything in sheet metal in the planning stage... consider, first, the Kirksite Tooling Service.

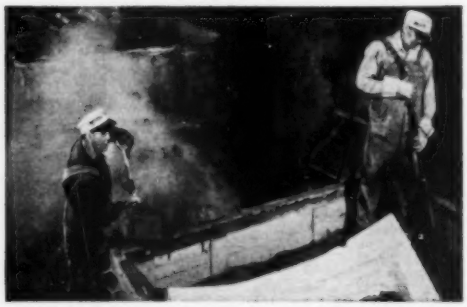
Get the full story. Write for a free copy of the new, illustrated brochure, "Kirksite." Address:

NATIONAL LEAD COMPANY
Kirksite Division
900 West 18th Street, Chicago, Ill.

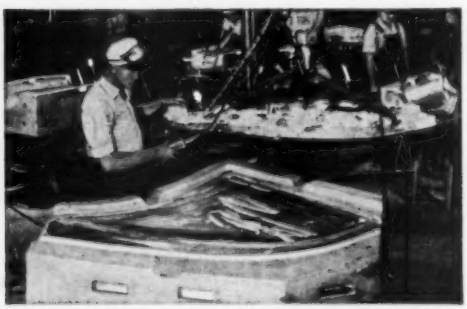
"Kirksite" is a trade-mark registered in U. S. Pat. Off. by Morris P. Kirk & Son, Inc., a subsidiary of National Lead Co.

*Reg. U. S. Pat. Off.

Pattern Making includes wood models or plaster models made from a loft template set-up, starting from an idea, a model, or a blueprint.



Sand Casting includes the molding and pouring of dies of any size or shape using special techniques in coring to reduce die weight.



Die Finishing includes grinding, drilling, planing, etc., to accurately finish dies to low tolerances by means of plaster check jigs, and templates.

Press Stamping and Finishing includes determination of cutting metal clearance, draw radii, drawface relief, etc. Also includes trimming, welding, re-working and spray-painting.

26 types and 5,850 sizes —as near as your telephone

EVERY so often, a machinery maker comes to the Timken Company for help with a very special bearing application. Something, he's pretty sure, we've never encountered before.

Almost always, we're able to give him a pleasant surprise. In over 50 years of helping manufacturers with special bearing problems, all the while improving our designs, we've produced an astonishing variety of tapered roller bearings. So many sizes and shapes that the "new" bearing has usually already been designed and made by the Timken Company. So many that the "new" design problem has usually been already solved with the help of Timken Company engineers.

If the people who buy the machines ever have occasion to replace a Timken® bearing, they get the same kind of pleasant surprise. Even when a machine's very old, they can almost always get immediate delivery on Timken bearings for replacement.

Be sure that every bearing you use in the machines you buy or build is stamped with the trademark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

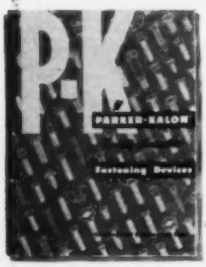
TIMKEN *TAPERED ROLLER BEARINGS*

TRADE MARK REG. U.S. PAT. OFF.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ▯→ LOADS OR ANY COMBINATION →✳←

"Speeds up and simplifies our product design job . . . helps us make sure our planned assembly savings pay off."

P-K CATALOG AND ENGINEERING DATA



Illustrates and describes all P-K products. Tells "where, when, how, and why" P-K Fasteners are used. Shows many typical applications. Gives all needed information for selection and application . . . 88 pages.

P-K SELF-TAPPING SCREW BULLETIN

A 48-page separate edition of the Self-tapping Screw section of the General Catalog.

P-K ENGINEERING STANDARDS BOOK

A 64-page book of standard head and thread dimension drawings of P-K Screws, other useful data.

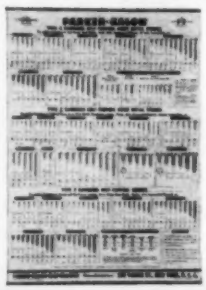
P-K SOCKET SCREW BULLETIN

A 16-page separate edition of the Socket Screw section of the General Catalog.

POWER DRIVING BULLETIN

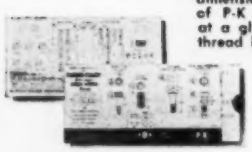
Describes and illustrates the various basic types of electric, air-operated, and impact tools for driving P-K Screws, as well as hopper-fed automatic driving machines in common use. Includes useful information on bit and socket selection.

P-K SCREW SIZE WALL CHART



Wall hanger, 18" x 24", illustrates in actual sizes all standard P-K Self-tapping Screws and other Fasteners.

SOCKET SCREW DIMENSION FINDER



Pocket-size plastic slide chart gives essential dimensions of all types of P-K Socket Screws at a glance, including thread length formula.

STAPS FOLDER

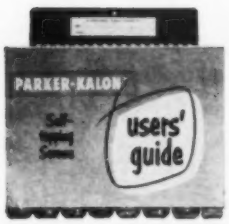
Describes the characteristics of Parker-Kalon STAPS and their primary applications. Shows various forms of pre-assembled neoprene washers available.

"HOW TO MAKE PLANNED SAVINGS PAY OFF" BOOKLET

A 24-page condensed catalog of P-K Self-tapping Screws explains P-K quality control. Pocket-size, and packed with information.

PARKER-KALON®
Assembly Planning Aids and Engineering Service

USERS' GUIDE



Plastic bound, 20-page index-tabbed 11½" x 9" work-book of technical information on selection and application of P-K Screws. Has "hang-up" tab. Popular with designers, engineers, and draftsmen for quick reference.

"HOW TO USE" BOOKLET

Pocket-size booklet of hole-size recommendations and other application information. Useful for quick reference by assembly supervisors.

FOLDERS ON INDIVIDUAL PRODUCTS

Screwnails, Masonry Nails, and other P-K products and services are described in folders which point out primary uses.

ASSEMBLY PLANNING AIDS Originator and largest producer of Self-tapping Screws, and pioneer in the development and improvement of other P-K fasteners, Parker-Kalon is a leading authority on assembly engineering. Through long experience in working closely with designers, product engineers, and others responsible for fastener selection, P-K has prepared technical literature exactly keyed to your needs. It is published in various forms planned to save reference time, yet provide all required information.

ASSEMBLY ENGINEERING SERVICE Parker-Kalon field representatives are fully-qualified Assembly Engineers. They can advise you how to plan assemblies to save fastening time, add product strength, and lower costs. When required, the modern facilities of a completely equipped laboratory in the P-K plant are available for testing new applications, and detailed reports will be furnished for your guidance.

Since Parker-Kalon offers a complete line, the P-K Assembly Engineer's recommendations for Self-tapping Screw selection are unbiased. The P-K method fits the *right* screw to the job.

Ask your local P-K Distributor for the P-K literature you need. If desired, he'll arrange for a P-K Assembly Engineer to call. Or write: Parker-Kalon Corporation, 200 Varick St., New York 14.

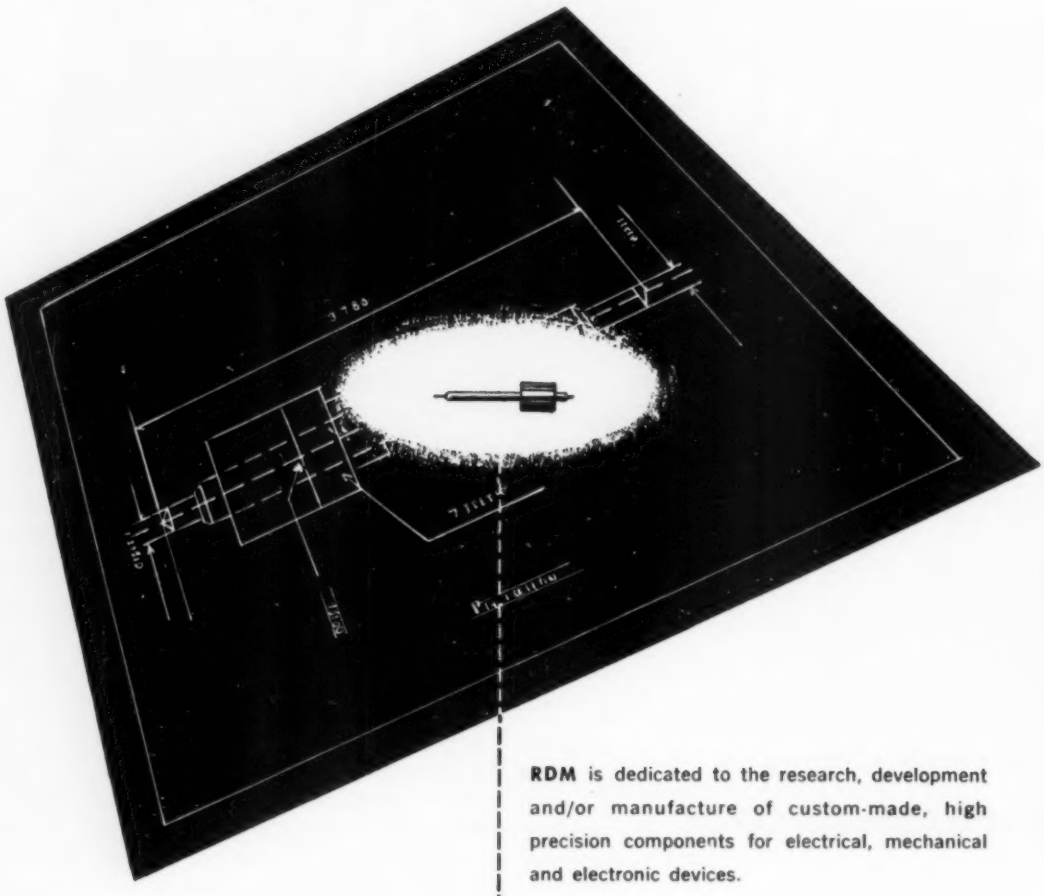
PARKER-KALON®

The Original **SELF-TAPPING SCREWS**

Cold-forged **SOCKET SCREWS**

AND OTHER FASTENERS

miniaturization through critically precise components



RDM is dedicated to the research, development and/or manufacture of custom-made, high precision components for electrical, mechanical and electronic devices.

Component reliability is the sole aim . . . the result, a perfect reproduction of the design. Made-to-order parts meet your most exacting tolerances and diverse requirements.

FOR DESIGN ENGINEERS, **RDM** PRECISION COMPONENTS OFFER UNLIMITED OPPORTUNITIES FOR SAVING SPACE, WEIGHT AND FRICTION WITHOUT THE SACRIFICE OF FUNCTION. FOR PRODUCTION ENGINEERS, **RDM** ELIMINATES COSTLY BOTTLENECKS.

Production schedules assured.
A brochure is yours for the asking. **WRITE**

THE AMERICAN NAME **RDM** IN SWISS PRECISION

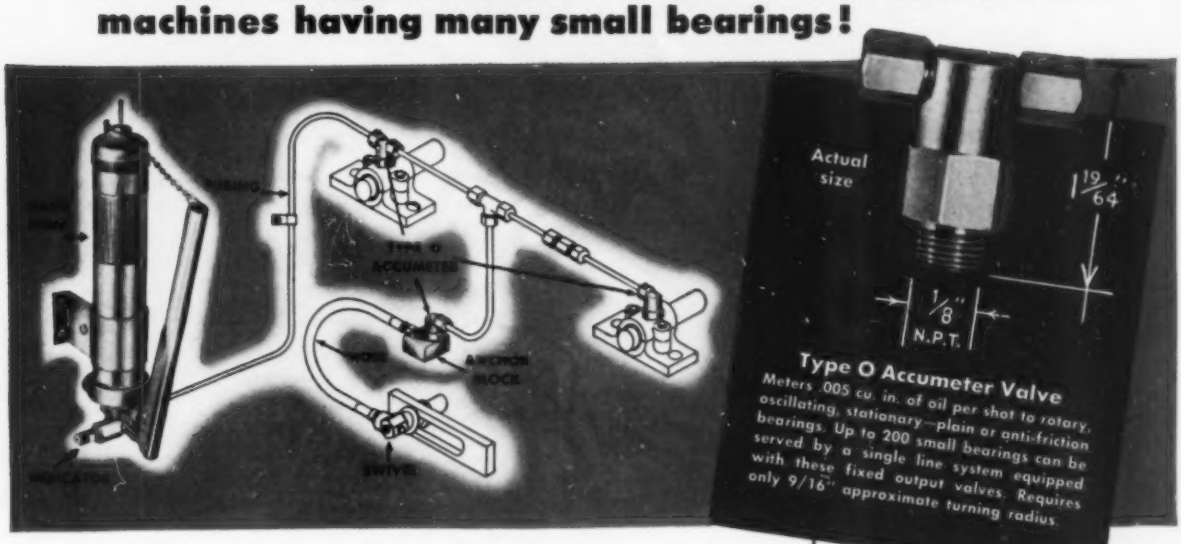
RESEARCH DEVELOPMENT MANUFACTURE, INC.
431 E. COLLOM STREET, PHILADELPHIA 44, PENNSYLVANIA

PINIONS • GEARS • SHAFTS • PIVOTS • BEARINGS • SPECIAL SCREWS

ideal... where close quarters make "ordinary" lubrication methods difficult...

ALEMITE Accumeter® CENTRALIZED LUBRICATION

lets you design low-cost, automatic lubrication into machines having many small bearings!


TUBING
TYPE O ACCUMETER
HOSE
ANCHOR BLOCK
SWIVEL
INDICATOR
Actual size
19/64"
1/8" N.P.T.
Type O Accumeter Valve
Meters .005 cu. in. of oil per shot to rotary, oscillating, stationary—plain or anti-friction bearings. Up to 200 small bearings can be served by a single line system equipped with these fixed output valves. Requires only 9/16" approximate turning radius.

Tiny, simple, accurate . . . Alemite Accumeter Type O Valves make it easy to design low-cost centralized lubrication into small machines, precision machines, *any* machine having many small bearings concentrated in limited space!

From One Central Point...in a fraction of the time required for hand lubrication . . . Accumeter Type O Systems deliver an exact, measured amount of fluid oil to *all* bearings—*while the machine is in operation!* No points missed... production time saved actually increases machine output. No wonder 95% of the big plants buying machine tools specify *centralized lubrication!*

Type O Accumeter System serves single machines or groups of machines—will handle any fluid oil. It is just one of three types of Accumeter Systems made by Alemite to meet your exacting requirements.

offers...

ALL THESE ADVANTAGES!

- **Eliminates shutdown time for lubrication. Adds productive time to machine output.**
- **Seals completely against dirt, grit, water all the way from "Barrel-to-Bearing."**
- **Prevents bearing troubles due to neglect or use of wrong lubricant.**
- **Services *all* bearings—including those inaccessible or dangerous—in one operation.**
- **Avoids work spoilage and bearing repairs due to over-lubrication.**

FACTORY-TESTED . . . FIELD-PROVED

Proved in the field. Exhaustive tests showed *no variation* in the amount of lubricant discharged . . . even after 73,312 lubrication cycles, *equal to 122 years of twice-a-day service.*

ALEMITE®

REG. U. S. PAT. OFF.

A PRODUCT OF SW STEWART-WARNER

Free—Alemite Accumeter Catalogue and Engineering Data Book.

ALEMITE, DEPT. T-103
1850 Diversey Parkway, Chicago 14, Ill.

Please send me my free copy of the Alemite Accumeter Catalogue and Engineering Data Book.

Name _____

Company _____

City _____ State _____

Are You

The chain habit is a good one to have when you're designing drives and conveyors. But *don't* be "chained" to just one particular type of chain. In the complete Chain Belt line there are literally hundreds of sizes and types of chain, each one designed to do a specific kind of work. Naturally, you want to select the chain that will perform most efficiently and economically over the longest period of time.

There's where your Chain Belt Field Sales Engineer can help you. You see, he is specially trained to study with you your chain selection problems. He can recommend from the complete Chain Belt line the one chain which will give the most satisfactory service in your

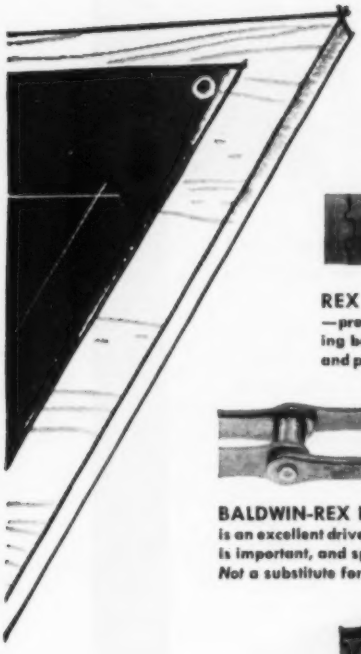
REX

BALDWIN-REX®

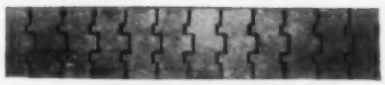
Chain

ATLANTA • BIRMINGHAM • BOSTON • BUFFALO
CHICAGO • CINCINNATI • CLEVELAND • DALLAS
DENVER • DETROIT • EL PASO • HOUSTON
INDIANAPOLIS • JACKSONVILLE • KANSAS CITY
LOS ANGELES • LOUISVILLE

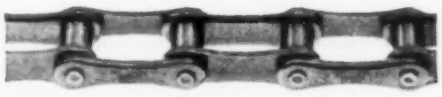
"CHAINED" By Habit?



REX® CAST PINTLE CHAIN—for slower speed drive and conveyor service where long life due to greater bearing area is needed.



REX TABLETOP® CONVEYOR CHAIN—provides a smooth, steady surface for conveying bottles, jars, cans, etc. Simple, two-piece link and pin construction makes for easy maintenance.



BALDWIN-REX DOUBLE PITCH ROLLER CHAIN is an excellent drive or conveyor chain where light weight is important, and speeds and loads are low to moderate. *Not* a substitute for standard roller chain.

BALDWIN-REX® STANDARD ROLLER CHAIN—ideal for high speed drives and timing applications. A wide range of attachments is available for every type of conveyor service.

BALDWIN-REX LEAF CHAIN—an excellent chain for tension linkage applications where linear movement of the chain is not continuous in direction. Used on lift trucks, hoists, controls, etc.

REX CHABELCO® STEEL CHAIN—especially suited for operation where loads are heavy and conditions of dust, dirt, and grit are encountered. This chain can really take it!

application. Illustrated here are just a few samples from our complete line. They are all quality chains built with over 60 years of chain-making experience behind them.

Next time you have a chain selection problem, why not call your nearest Chain Belt branch office; or if you prefer, just mail the coupon. Chain Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wis.

Belt COMPANY
OF MILWAUKEE

MIDLAND, TEXAS • MILWAUKEE • MINNEAPOLIS
NEW YORK • PHILADELPHIA • PITTSBURGH
PORTLAND, OREGON • SPRINGFIELD, MASS.
ST. LOUIS • SALT LAKE CITY • SAN FRANCISCO
SEATTLE • TULSA • WORCESTER

Chain Belt Company, 4715 W. Greenfield Avenue 52-104
Milwaukee 1, Wis.
Gentlemen:
I am particularly interested in chains for the following purposes:
.....
.....
Please send me appropriate literature.
Name.....
Address.....
City.....*State*.....

DIE CASTING
eliminates four, expensive screw machine parts

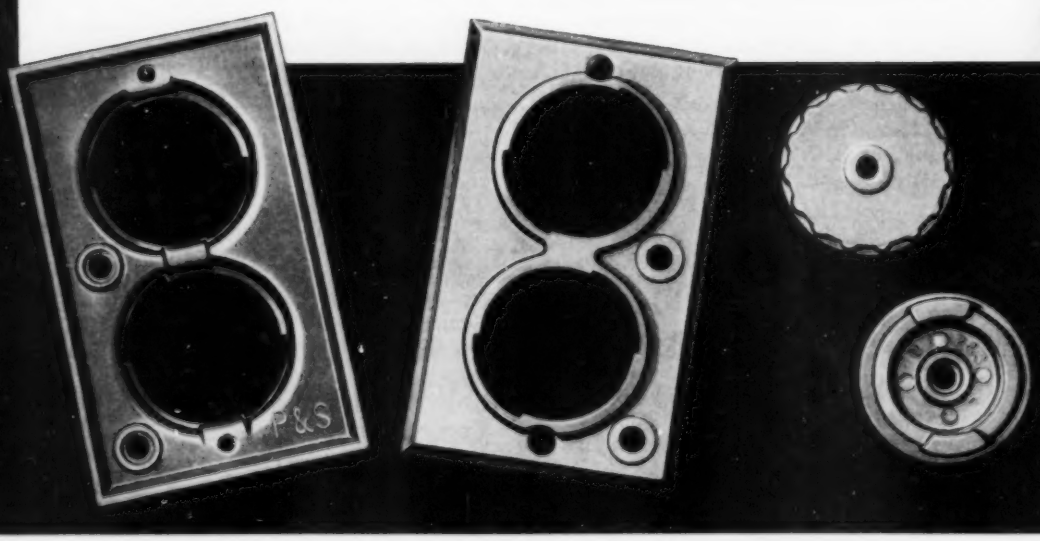
CASE HISTORIES FROM MT. VERNON FILES

When you're looking for ways to pare your production costs and boost your output on metal parts, investigate die casting.

Die casting permits you to produce *intricate* metal parts or sections in a single operation. This reduces and often eliminates, the need for much machining and finishing. As a result, you save time and material. And frequently you can simplify design and lower weight without sacrificing strength or performance. Naturally, you get *better* products, *faster*, and at a *lower* unit cost.

Pass & Seymour's new weatherproof electrical outlet clearly illustrates these advantages. Specifications for this outdoor outlet called for tight fitting, removable caps to make it weatherproof when not in use. Previously, P & S used threaded caps and housings which required four, expensive screw machined parts. Now, die casting has eliminated these parts—resulted in a much more satisfactory product. The new outlet has no threads to cross or catch. Its positive latching cap will not loosen, yet may be latched and unlatched with a simple turn. And its large die cast serrations provide a firmer grip.

The next time *you* have to select a manufacturing procedure remember these advantages of die casting—and consult us. We'll welcome the opportunity to show you how die casting can increase *your output*, improve *your products* and hold down *your production costs.*



WE MAKE AND FABRICATE . . .
STRONG, LOW-COST SPIRAL TUBING

Spiral Tubing, another outstanding C-D-F product, is an important new material for the progressive, cost conscious design engineer (and purchasing agent). It is a high strength plastic made from paper or fibre that is spirally wound, then impregnated with phenolic resin or insulating varnishes and carefully cured at high temperatures. The resulting tubes (round, square, rectangular or formed to special shapes) are stiff, sturdy, resistant to crush, with good tensile strength.

This unique product has good dielectric strength with low dielectric loss properties. Moisture resistance and dimensional stability is easily controlled in the manufacturing process. The wide variety of sizes, shapes, forms; the strength; low cost; ease of fabrication; speed of delivery; all combine to make C-D-F Spiral Tubing worthy of your investigation.

PRIMARY APPLICATIONS

COIL FORMS OF ANY SIZE OR SHAPE
for tuned or untuned RF, IF, oscillator, and other coils used in radio, television, electronic circuits
for solenoids, relays, circuit breakers
for transformers
for permeability tuners

INSULATORS
for selenium rectifiers
for electric motors
relays

BUSHINGS OR SPACERS
armature shaft spacers
for mechanical support

SHIPPING PROTECTORS AND FOR SPECIALIZED PACKAGING

BOBBIN TUBES

BODIES FOR PAINT ROLL APPLICATORS

AS A COMBINATION MATERIAL
with other C-D-F high strength plastics or electrical insulating materials

SIZES

The round tubing ranges from 3/32 to 8" ID, with wall thicknesses from .0075 to ¼". The minimum ID of square and rectangular tubing is ⅜", with 2⅛" the maximum ID. Wall thicknesses range from .010 to 3/32".

Standard lengths are from 2 to 4', with special sizes and grades, plain or impregnated, open for your discussion with our C-D-F sales and engineering staff.

FABRICATION

Spiral Tubing is readily sawed, punched, drilled, tapped, riveted, stamped, painted, depending on the grade; it is suitable for automatic machine operations, but not recommended for conventional machine threading. Waxing or varnish impregnation to improve moisture resistance is usually done on the finished coils by the user.

GRADE SELECTION

C-D-F has mass production facilities for both the manufacture and fabrication of eighteen distinct grades of Spiral Tubing. For example, there's a special punching grade, fine for punching rectangular or square holes near the end of the tube. A relatively soft tube is supplied for difficult stapling or riveting. C-D-F makes high strength automotive electrical bushings from a very hard tubing with high axial compressive strength. Combinations of kraft, chipboard, Diamond "fish paper" Insulation, and other materials are available.

FORMS: ROUND • FORMED • FORMED AND NOTCHED • SQUARE AND RECTANGULAR

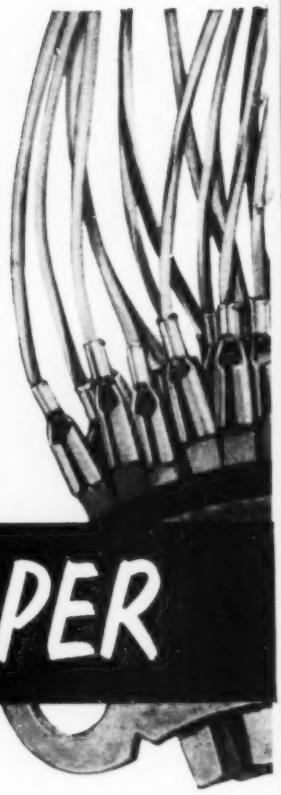
THE NAME TO REMEMBER FOR SPIRAL TUBING

Continental-Diamond Fibre Company

NEWARK 81, DELAWARE

Remember, C-D-F has production know-how, years of experience in electrical insulation. See your C-D-F sales engineer. Write now for new 1953 spiral tubing folder, a workbook showing grades, applications, properties.

A NEW TERMINATION TECHNIQUE FOR . . .



- COMPUTERS
- SWITCHBOARDS AND INSIDE PLANT EQUIPMENT
- RELAYS, SWITCHES, AND MULTI-CIRCUIT COMPONENTS

AMP FLAT* TAPER

If you are concerned with the wiring of close spaced equipment, investigate the new AMP Solderless TAPER TAB RECEPTACLE for flat relay or switch tabs shown at right. It is self locking when installed on a male tab with matching 3½° taper, yet can be removed and reconnected any number of times without solder or special tools. These terminals are supplied on reels in continuous strip. Customer crimps them on wires using AMP automatic machines at speeds up to 4,000 per hour!

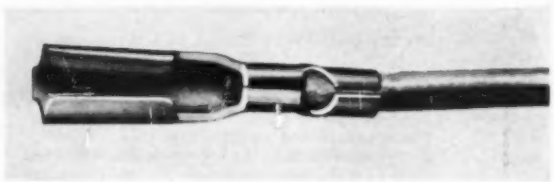
Performance of these miniature connectors meets exacting requirements for millivolt drop, corrosion resistance, and vibration. They are suited for critical low level circuits or power circuits up to several amperes.

Write to AMP Electronics Division for complete information concerning AMP TAPER TAB RECEPTACLES . . . you will receive data and samples by return mail.

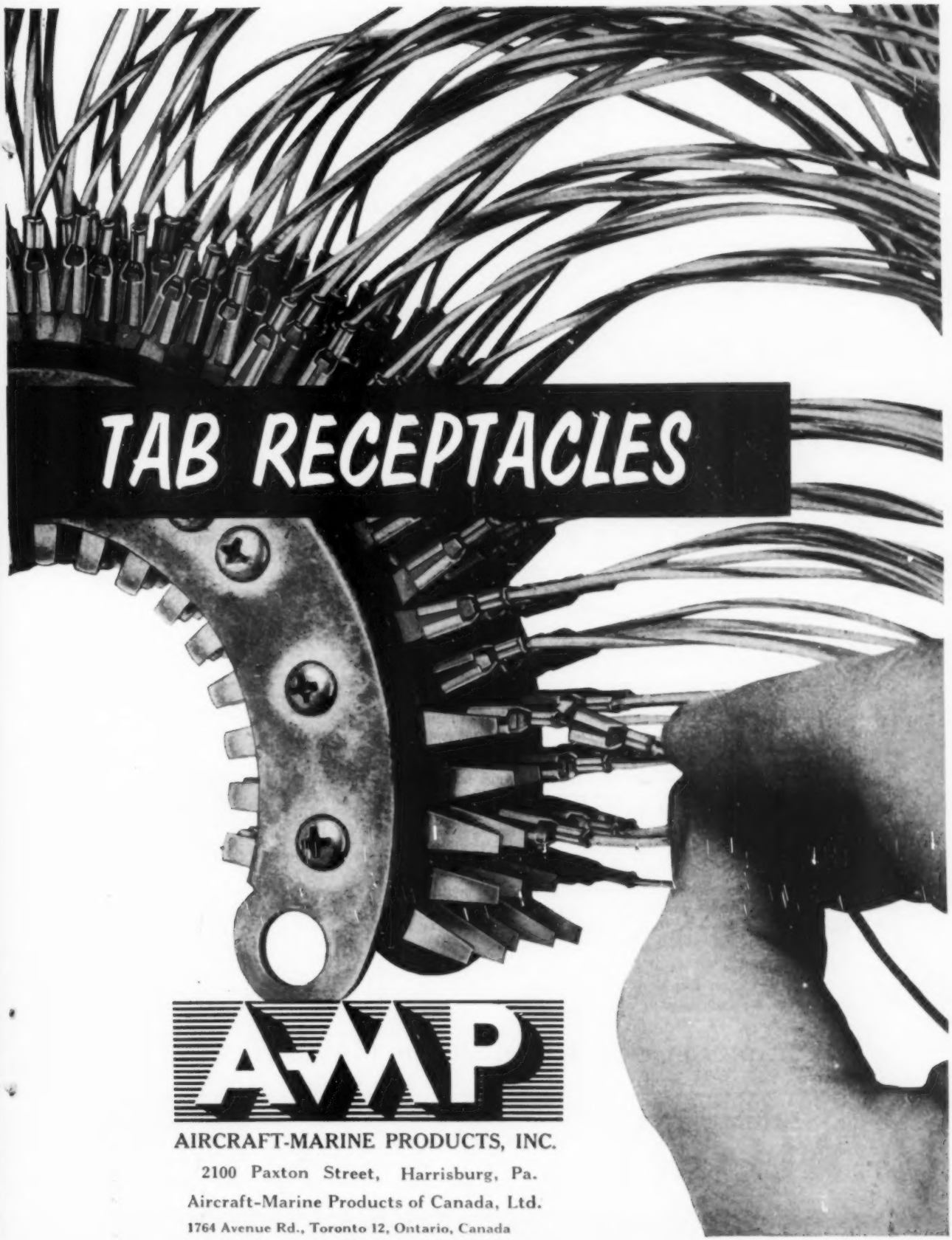
An example of the savings possible with Taper Tabs and Receptacles. This disconnect block in Remington Rand's new electronic computer had more than 1,000 wires soldered to tabs in a space approximately 5" x 9"—an assembly operation requiring two weeks' time. After tabs were modified to taper shape (See picture insert), the same operator can now assemble two blocks per day—a 20 to 1 increase—using A-MP's Taper Tab Receptacle No. 41355. There are neither loose wire ends nor drops of solder in the assembly to cause shorts nor cold or rosin joints to open up in the field. Installation is simply a mechanical operation requiring little operator skill, resulting in greater uniformity.

*For connector plugs and other applications where a round pin is more adaptable, see AMP taper pins.

PHOTO AT RIGHT SHOWS AMP SELF LOCKING TAPER TAB RECEPTACLES BEING APPLIED TO MATING TABS ON A STEPPING SWITCH. LOCKING ACTION GIVES MAXIMUM ELECTRICAL AND MECHANICAL SECURITY . . . CONNECTIONS ARE SUITABLE FOR CRITICAL LOW LEVEL CIRCUITS.



© AMP AMP Trade-Mark Reg. U. S. Pat. Off.

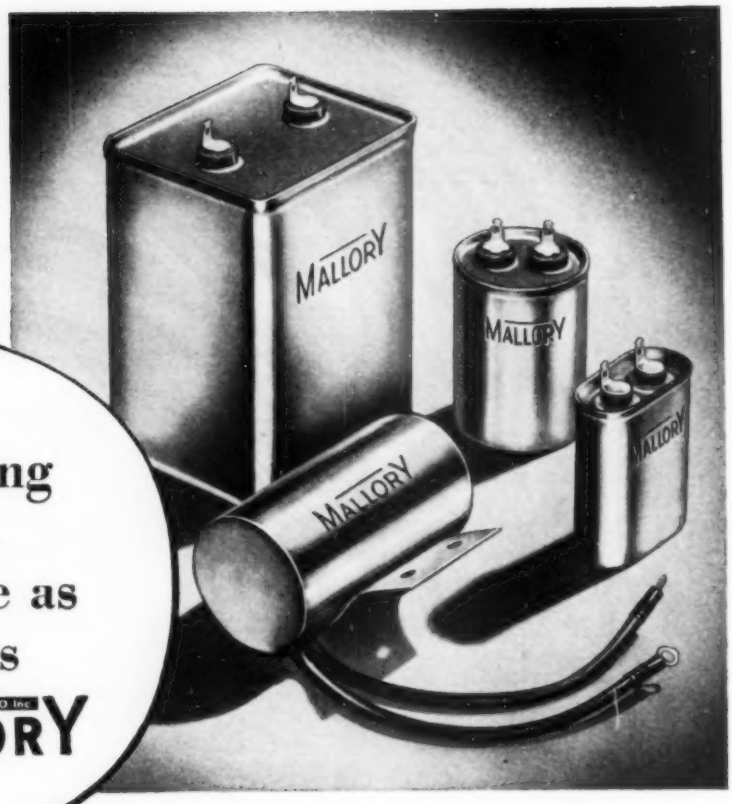


AIRCRAFT-MARINE PRODUCTS, INC.

2100 Paxton Street, Harrisburg, Pa.

Aircraft-Marine Products of Canada, Ltd.

1764 Avenue Rd., Toronto 12, Ontario, Canada



For Motor Running Capacitors as Dependable as Your Motors

Specify P.R. MALLORY & CO. Inc. MALLORY

Not one field reject since we first started production!

For dependability, you can't beat that! To you it means uniformity . . . trouble-free operation for your motors under the most difficult conditions.

You'll find one of the reasons for this record is rigid material specifications. Special dry type foil and premium quality paper form the heart of the capacitor. Mallotrol "A", the non-inflammable liquid impregnant has high dielectric strength and exceptional stability. Silicone terminal bushings contribute to high insulation resistance and low power factor.

Another reason is the modern laboratory and production facilities at Mallory. Rigid quality control governs every step of production, right through inspection, where each unit is checked for voltage breakdown, capacity and oil leakage.

When you standardize on Mallory motor running capacitors, you are standardizing on trouble-free performance . . . long life. Write today for more information.

You can also depend on Mallory Plastic Case AC Motor Capacitors.

They offer superior protection against humidity, better heat dissipation, outstanding performance at high temperatures and fast, easy mounting—either on or off the motor.

Expect more . . . Get more from P.R. MALLORY & CO. Inc. MALLORY

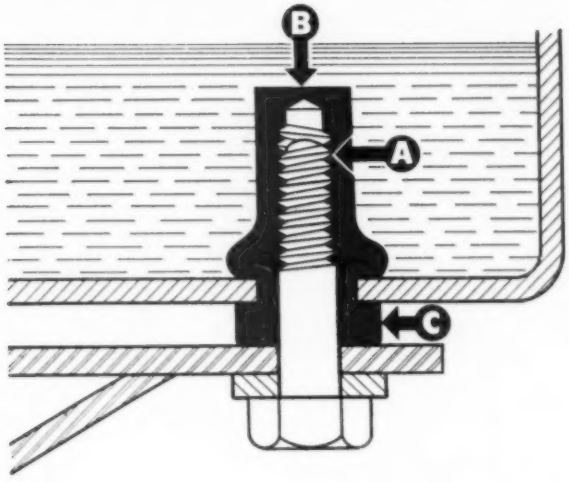
P.R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

B. F. Goodrich RIVNUT replaces nut plate... cuts out leaking, warping, thread cleaning

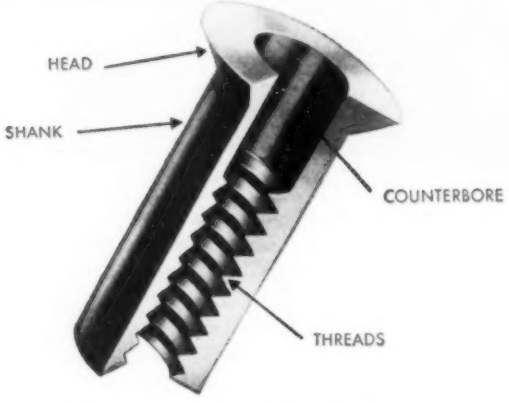


A MANUFACTURER of industrial oilers was brazing nut plates on his reservoir tanks for bolting to brackets. This sometimes caused leaks and warping. Since painting had to follow brazing, the threads had to be retapped.

By switching to Rivnuts, brazing was eliminated. Installed from one side, after painting, in one-tenth the time required for brazing, Rivnuts provide at least six clean threads (A) to take the attachment bolt. Rivnut forms oil-tight seal, has closed end (B). Special spacer head (C) of Rivnut forms uniform height feet.

Closed-end Rivnut with spacer head is one of many types of Rivnuts. If you have a fastening problem, consult a Rivnut engineer. Write to The B. F. Goodrich Company, Dept. PE-103, Akron, Ohio.

THIS IS A B. F. GOODRICH RIVNUT . . . . THIS IS HOW IT WORKS

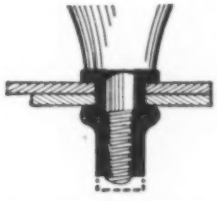


This cross-section shows the threads by which the Rivnut is threaded onto the pull-up stud of the heading tool. These threads are not injured by the heading operation and enable you to fasten *to* a Rivnut as well as *with* it.

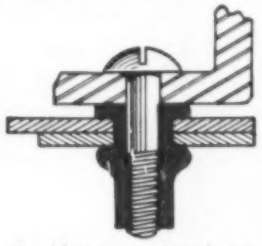
The Rivnut provides a large bearing surface, requires only a small hole, and can be installed after enameling without marring the finish.

1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2. Rivnut is inserted, head firmly against work, tool at right angles to work.



3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4. After upset, threads are still clean and intact, ready for screw attachment.

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnut works. Explains construction, gives applications. Write to: B. F. Goodrich, Dept. PE-103, Akron, O.

Bendix

presents

a New Low Tension, Hi-Output

LAR Magneto

...with

HIGH OUTPUT COIL, this Bendix coil is specially designed to give high compression engines maximum performance.

SINGLE ELECTRICAL OUTLET Only one electrical connector, the famous Bendix-Scinflex type required for all low tension outlets.

This new type LAR Bendix Magneto incorporates all the outstanding characteristics of its famous predecessor the LA Magneto plus important additional features.

The LAR series Magnetos utilize a single Bendix-Scinflex electrical connector for all low tension outlets, including the ground terminal. This permits quick, easy installation since all electrical connections are in the one plug-in connector.

In the interest of standardization, dimensions are held as closely to the standard LA Magneto as possible and mounting dimensions are identical.

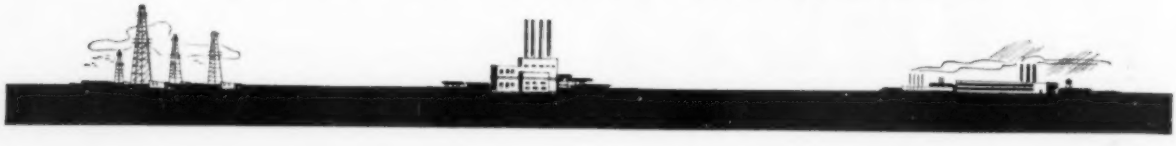
Designed for high compression ignition requirements, the LAR Magneto has all the engineering quality that has made the name Bendix "The Most Trusted Name in Ignition."

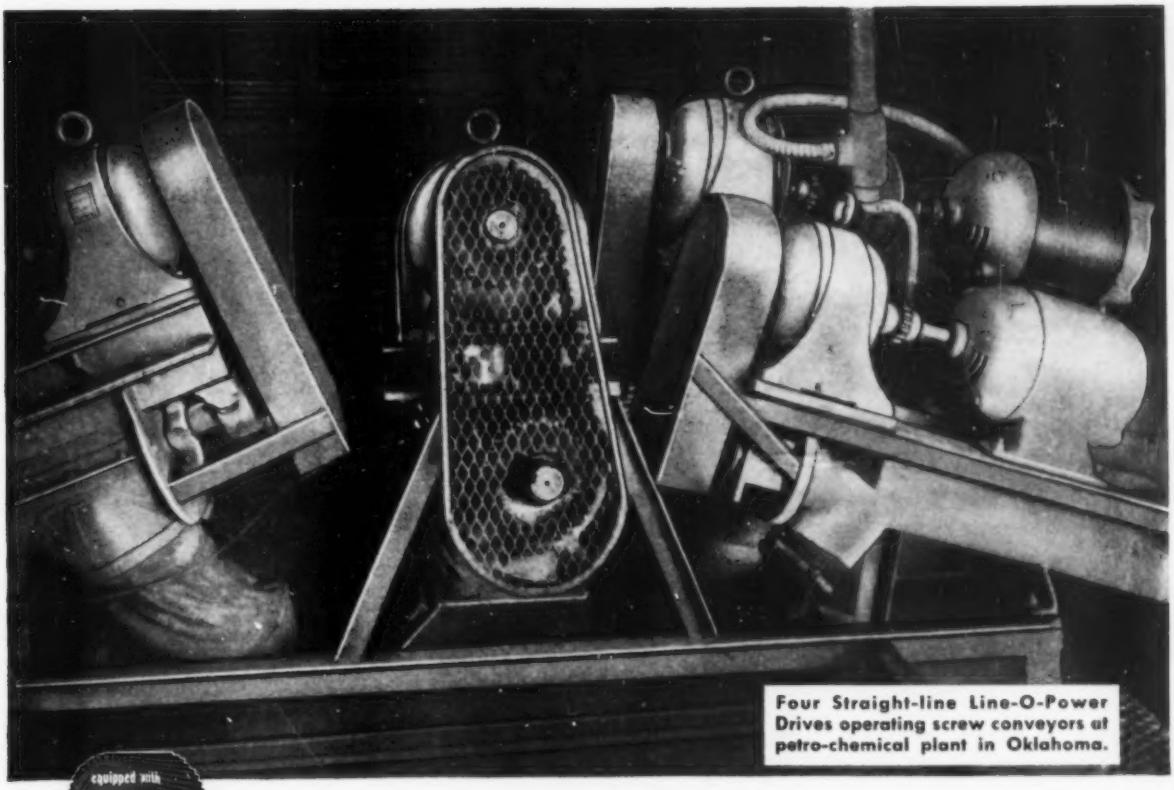
Descriptive folder available on request.

Bendix **SCINTILLA MAGNETO DIVISION of** Bendix
SIDNEY, NEW YORK — AVIATION CORPORATION

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N.Y.

FACTORY BRANCH OFFICES: 118 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan
Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California





Four Straight-line Line-O-Power Drives operating screw conveyors at petro-chemical plant in Oklahoma.

equipped with FOOTE BROS. Duti-Rated LIFETIME GEARING

This Trademark Stands for the Finest in Industrial Gearing

solve your space and weight problem . . . with LINE-O-POWER*

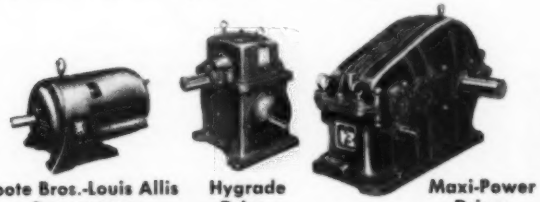
When limited space governs a reducer's size — when weight is a critical factor — LINE-O-POWER is your drive.

Line-O-Power Drives are smaller, lighter, more compact — yet offer almost any reduction you need — because Duti-Rated Lifetime Gearing assures maximum load-carrying capacity in minimum space. Newly-developed Duti-Rated Gears have high hardness, extreme accuracy — permit *big* savings in size and weight.

Longer life — higher efficiency — quieter operation — these are Line-O-Power advantages, brought about by Duti-Rated Lifetime Gearing, unmatched in the industrial gear field.

Sturdy Line-O-Power Drives are available for prompt delivery — in straight-line or right-angle design — with foot or flange mountings — for horizontal or vertical service. Talk over your requirements with the Foote Bros. representative, or write for helpful information.

*REG. U. S. PAT. OFF.



Foote Bros.-Louis Allis Gearmotors | Hygrade Drives | Maxi-Power Drives

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. W, 4545 South Western Boulevard, Chicago 9, Illinois

Please send information about Line-O-Power Drives.

- ☐ Bulletin LPB on Straight-Line Units.
- ☐ Bulletin LWA on Right-Angle Units.

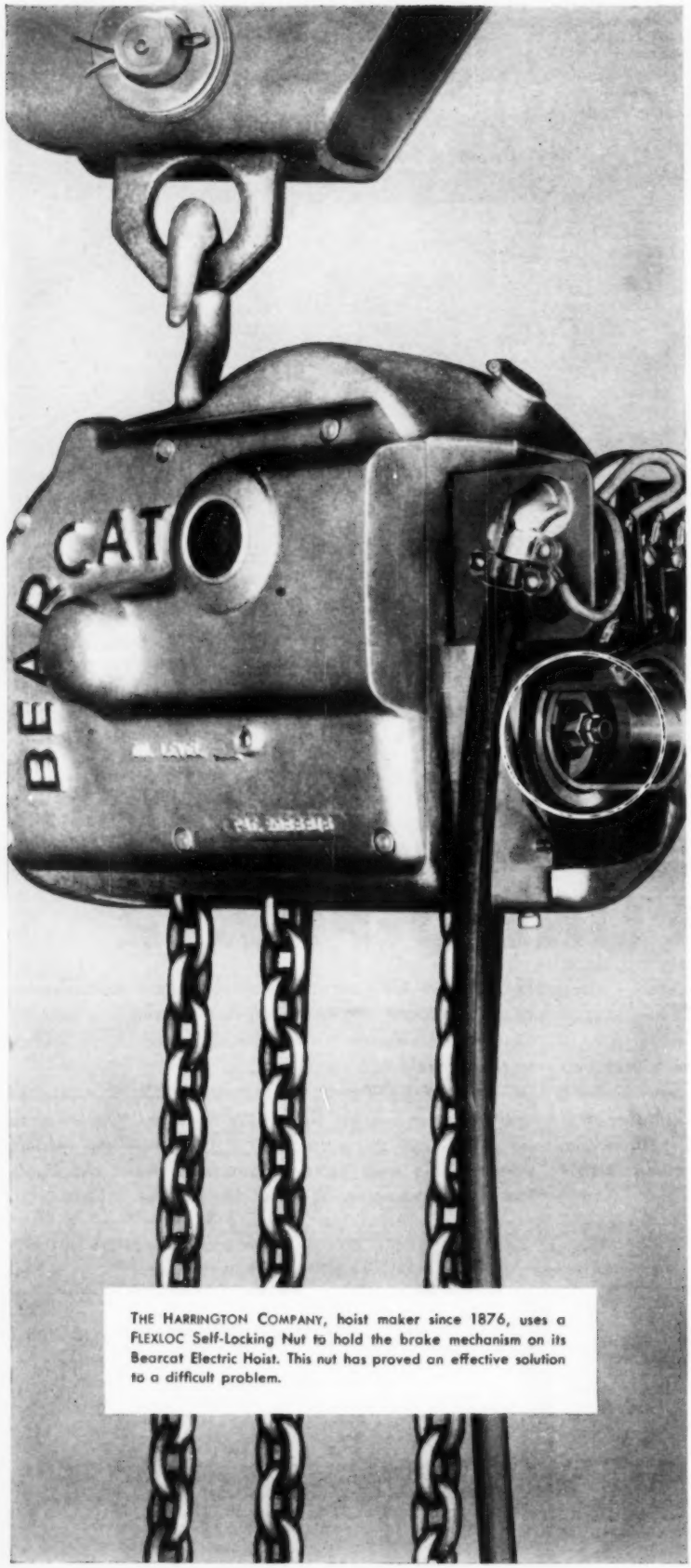
Name.....

Position.....

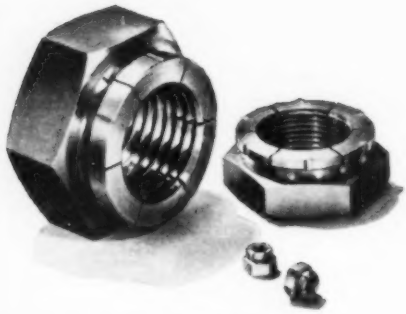
Company.....

Address.....

City.....Zone.....State.....



THE HARRINGTON COMPANY, hoist maker since 1876, uses a FLEXLOC Self-Locking Nut to hold the brake mechanism on its Bearcat Electric Hoist. This nut has proved an effective solution to a difficult problem.



Why FLEXLOCs are better locknuts

Compare the features of FLEXLOCs with those of any other nut, and you'll readily see why we say they are better locknuts.

FLEXLOCs are one piece, all metal. They require no lockwasher, no cotter pin, no auxiliary locking device to keep them on a bolt. They are not affected by moisture, dust or high temperatures. Standard FLEXLOCs are designed for temperatures up to 550° F.

FLEXLOCs are stop and lock nuts. They won't work loose once their locking threads are fully engaged; therefore they stay put anywhere on a bolt. Seating is unnecessary. And FLEXLOCs can easily be removed from a bolt and reused again and again without losing their locking ability.

For more information about FLEXLOCs and samples for test purposes, see your FLEXLOC distributor, or write SPS, Jenkintown 28, Pa.

FLEXLOC®

LOCKNUT DIVISION

SPS

JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE

ORANGE ROLLER BEARINGS

ORANGE ROLLER BUSHINGS

Maximum load capacity in small space

Install these space-saving needle bearings to provide friction-free, long-life operation of rotating and oscillating parts in your equipment. Closer internal running clearances minimize possibility of misaligned rollers. Quiet, even running. Stock sizes ½" to 8" shaft diameters.

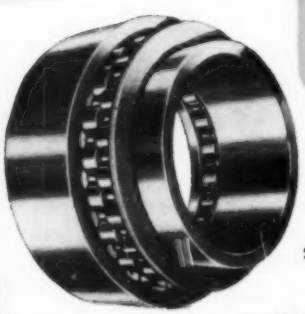
ORANGE *Cage Type* NEEDLE BEARINGS

Prevent Roller Skewing

Anti-friction cage keeps rollers permanently aligned in any position—vertical, tilted, horizontal. Successful on overhung mountings and relatively high-speed installations; less affected by misaligned mountings or uneven loading. Extremely smooth, quiet running. Sizes ½" to 8" shaft diameters.

Send for Engineering Data Books
showing dimensions, capacities, shaft and housing tolerances and fits, installation data, etc.

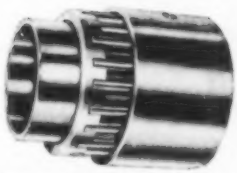
Submit your Engineering Problems
to our field engineers conveniently located in all industrial centers. Our engineering department invites you to submit details or drawings on any bearing application, for recommendation.



For heavy loads and severe service

ORANGE "STAGGERED" ROLLER BEARINGS

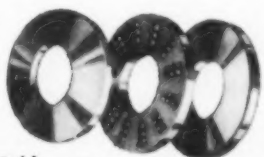
End views show how staggered roller arrangement distributes load over many short rollers. This also prevents skewing tendencies of long rollers and provides more even running. These features often permit use of smaller sizes—always assure longer service life. Full range in 200 and 300 series.



ORANGE JOURNAL ROLLER BEARINGS

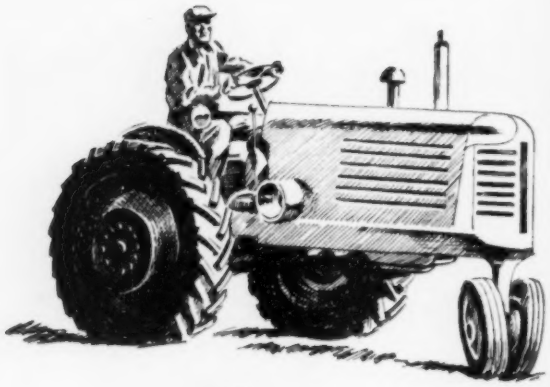
Provide high load capacity where radial space is limited, such as shafts close together or adjacent to shoulders. Sizes ¾" to 4" shaft diameters.

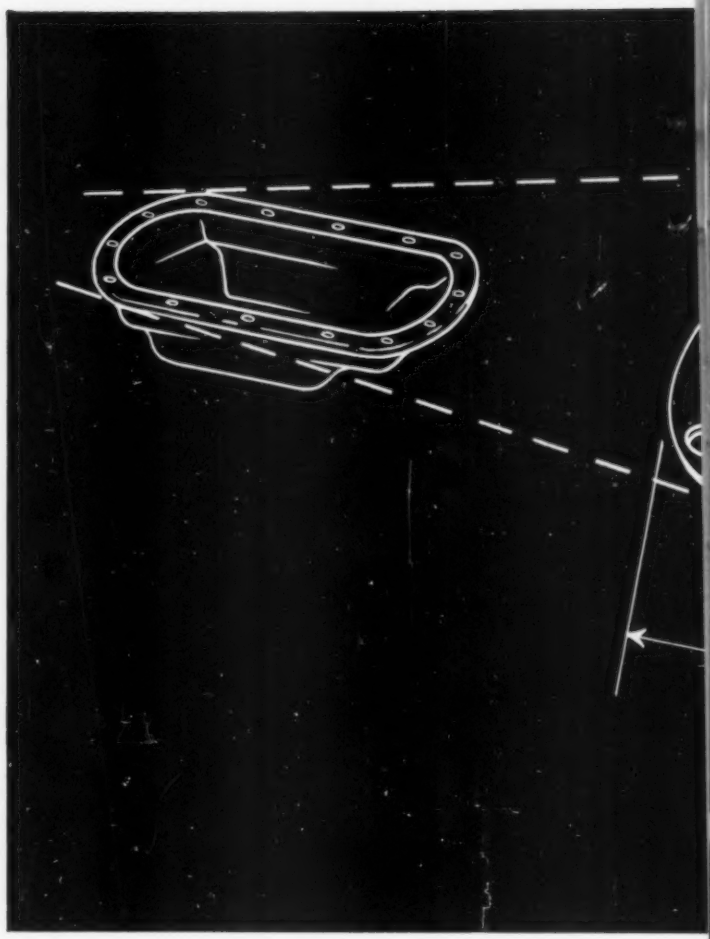
ORANGE THRUST ROLLER BEARINGS



Designed to provide maximum roller support for the load, with minimum wear. Available in designs and sizes to meet varying requirements.

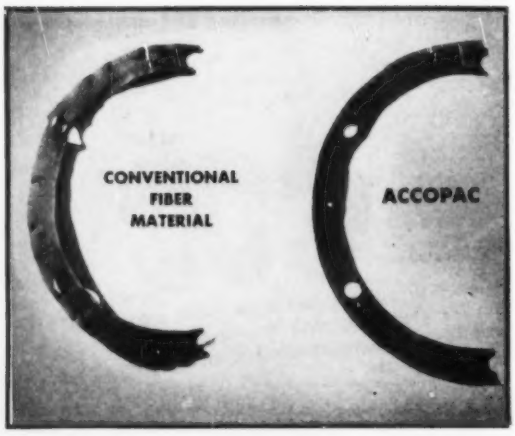
ORANGE ROLLER BEARING CO., Inc. 551 Main St., Orange, N. J.





This fiber gasket

...seals perfectly—keeps



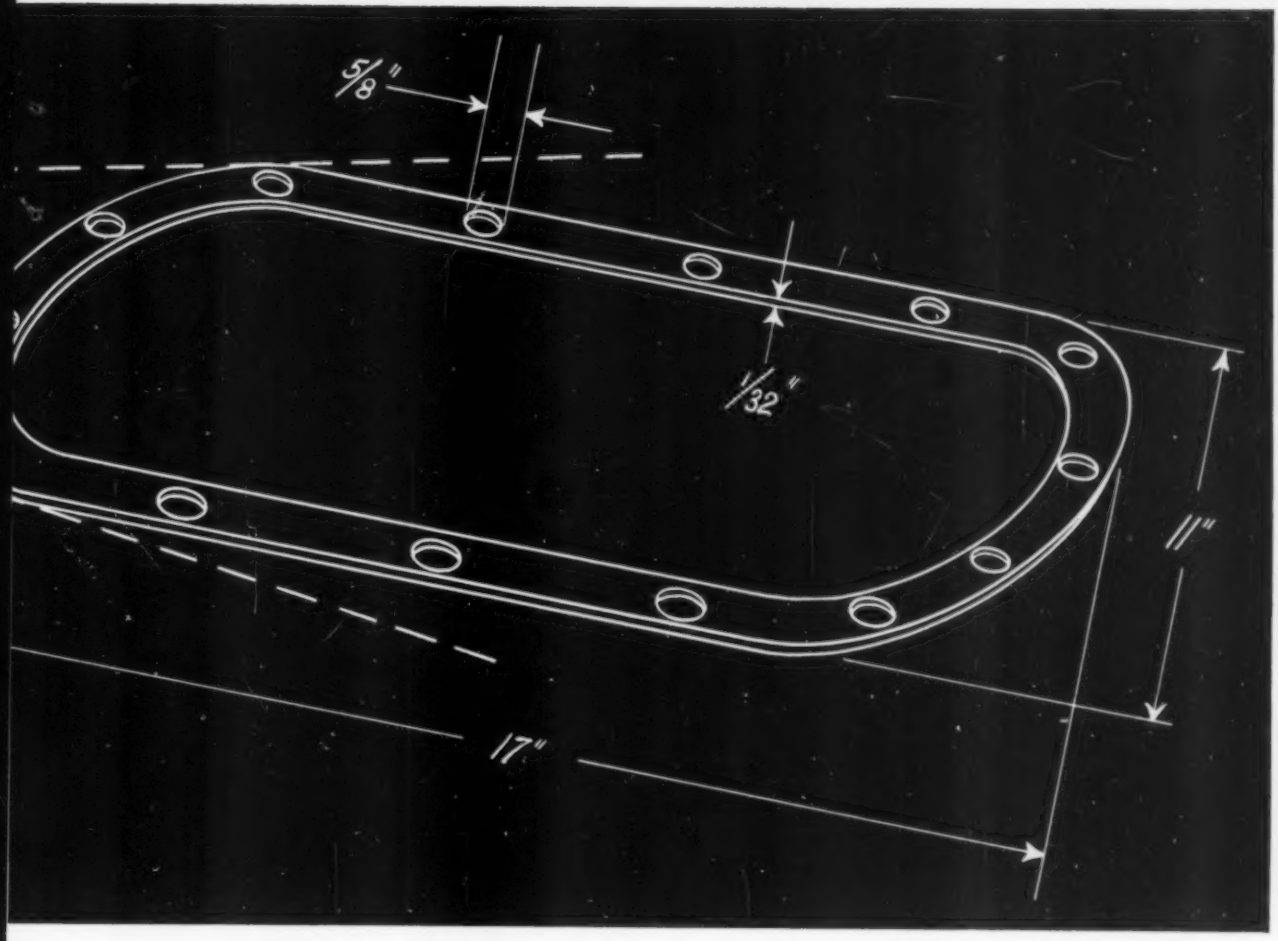
WON'T SHRINK OR DRY OUT. After 6 months in a gear pump circulating hot oil, the conventional gasket lost its glycerine content, dried out, and leaked. Accopac gasket was virtually unaffected, still provided a good seal.

Trial runs on a new tractor engine revealed that hot engine oil was leaching the saturant out of the fiber oil pan gasket. Leakage resulted and the seeping oil, mixed with field dust, formed unsightly accumulations of grime on the motor block.

Several other fiber materials were tested with the same result. Then this manufacturer tried a new kind of fiber material—Armstrong's Accopac®—and solved his problem. In a series of 2500-hour lab tests and three-month field tests, not one Accopac gasket leaked.

Won't shrink or dry out. Accopac gaskets gave that kind of performance because of the way Accopac is made. Fiber, cork, and rubber binder are locked together by Armstrong's new beater saturation method which makes each sheet uniformly strong. Accopac gaskets won't shrink, dry out, or leak in any recommended application.

ARMSTRONG'S



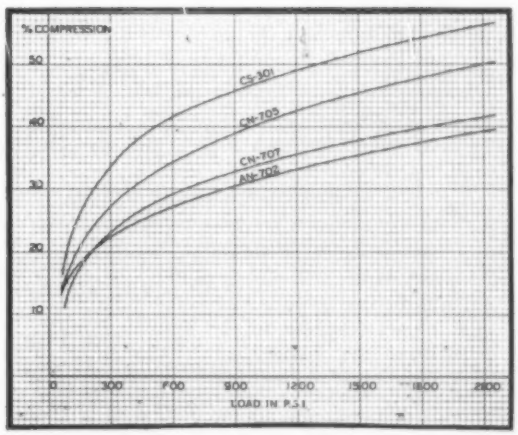
tractor engine clean and efficient

Ideal for replacement gaskets. Accopac's dimensional stability and sealing efficiency are not noticeably affected by humidity changes. This makes Accopac ideal for replacement gaskets. Even after months in a warehouse or garage, Accopac gaskets still fit and seal perfectly.

Accopac is available in sheets, rolls, ribbons, or die-cut shapes. For samples, call your Armstrong representative or write directly to the address below.

SEND FOR GASKET DATA BOOK!

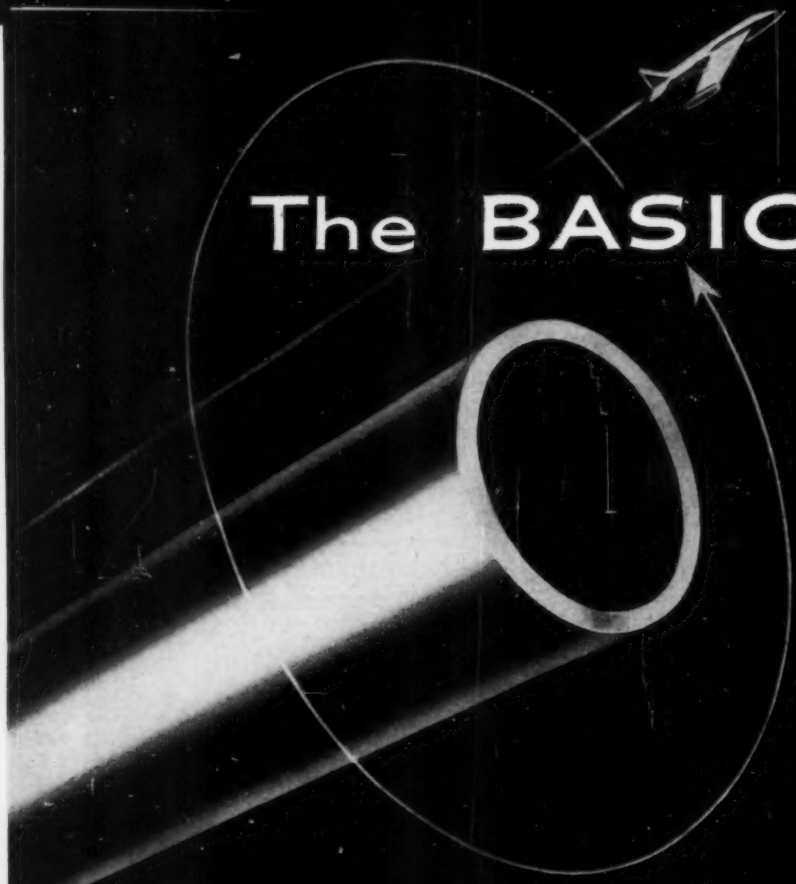
This 24-page manual, revised for 1953-54, gives you full information on all Armstrong's gasket materials, along with latest government and SAE-ASTM specifications. It contains helpful information, too, on the design and use of gaskets, covers topics like Designing Gaskets to Reduce Costs, Practical Tolerances, etc. Write Armstrong Cork Company, Industrial Division, 7010 Irvin Street, Lancaster, Pennsylvania.



HIGH COMPRESSIBILITY of Accopac is shown by load compression curves. Even on light or stamped metal flanges, this compressibility allows gaskets to conform to surface irregularities and seal without distorting the flange.

ACCOPAC

The BASIC SHAPE of things to come!



WHEN you use Shelby Seamless Mechanical Tubing for hollow cylindrical parts, the basic shape—the tube—is already made.

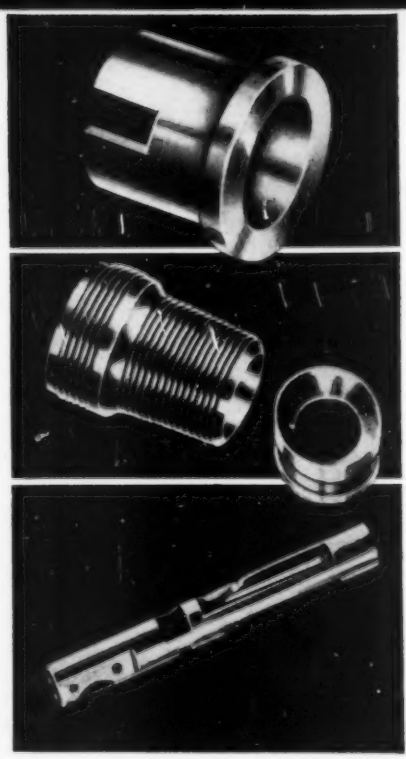
You pick up the job where Shelby leaves off, and you find that it requires much less cutting or boring than solid bar stock or forgings would.

You fashion the most complex of parts, yet you produce them faster and at lower cost than identical parts machined from solid bar stock.

You turn out a far better precision product, yet fewer operations are involved, man and machine hours are reduced, rejects are fewer, and over-all parts production is speeded up.

In some instances, the use of Shelby Seamless Tubing has increased production to such a degree that savings of 50 percent have resulted.

Shelby offers you the high strength, the uniformity, the dependability that only *seamless* tubing can give. And it's available in a complete range of diameters, wall thicknesses, and analyses to meet the most exacting requirements. If you're interested in cutting production costs—and who isn't?—while turning out a superior product, send for our free Bulletin Number 17. And feel perfectly free to call on our engineers if you need help in applying Shelby Seamless Steel Mechanical Tubing to your product.



NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

Learn how Farval can protect your machines and save you money

FARVAL—*Studies in Centralized Lubrication* No. 151

THIS new 20-page databook brings you up-to-date on centralized lubrication. In words, pictures and diagrams, Bulletin 26 shows you how simply and economically Farval systems operate.

The step-by-step operation of the unique Farval Dualine valve is presented in a series of color drawings. Its outstanding features are discussed. Detailed information on Farval systems is given, including manual systems, heavy-duty automatics, the compact automatic DC 20 specifically designed for smaller machines and the Spray Valve system designed to lubricate open gearing and slide surfaces evenly.

All about user benefits, too

Bulletin 26 also summarizes briefly the experience of Farval users. On many machines Farval eliminates 45 minutes or more out of every hour of hand-oiling labor. Farval protects bearings, thereby reducing the expense of dismantling machines. By keeping equipment steadily at work, Farval increases machine production. Farval saves 3 of every 4 pounds of lubricant used by other methods. In short, the economies due to Farval centralized lubrication usually pay for the installation in a few months and continue thereafter to pay handsome dividends.

Mail coupon today. You'll be surprised at the savings and the longer machine life you may enjoy with Farval. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

FREE — **Just off press! Bulletin 26 has 20 pages of photographs, drawings, diagrams and text, to enable you to select and specify the proper Farval systems to protect your machines. Mail coupon today!**

Yes, please mail my FREE copy of the new Farval Bulletin 26 without obligation.

Name_____

Title_____

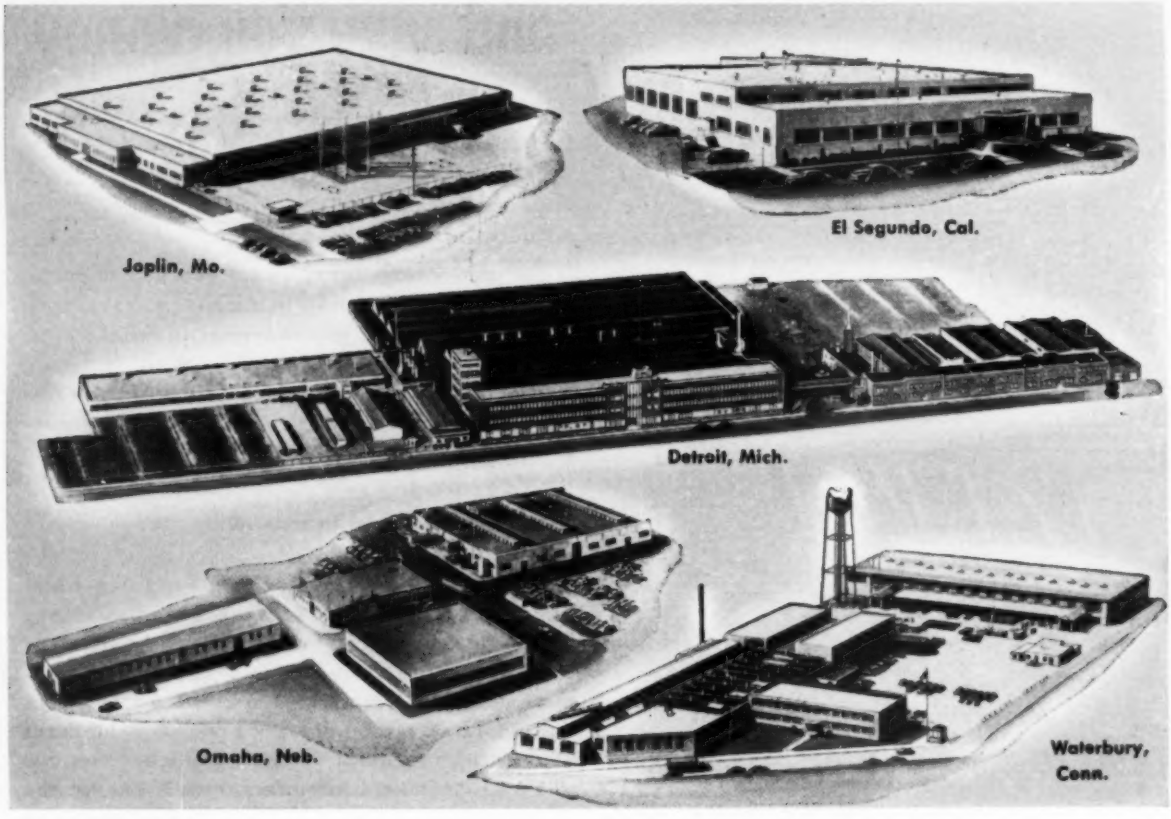
Company_____

Street_____

City_____ State_____

ONE OF A SERIES

You Get Many Benefits by Specifying VICKERS Hydraulics



Unmatched Facilities

For Hydraulics Development, Design, Manufacturing and Application

In resources for research, design, development, manufacturing and application, Vickers is unmatched in the hydraulics field. The five plants shown above employ more than six thousand people. These plants are strategically located to best serve the diversified industries that use Vickers Hydraulics.

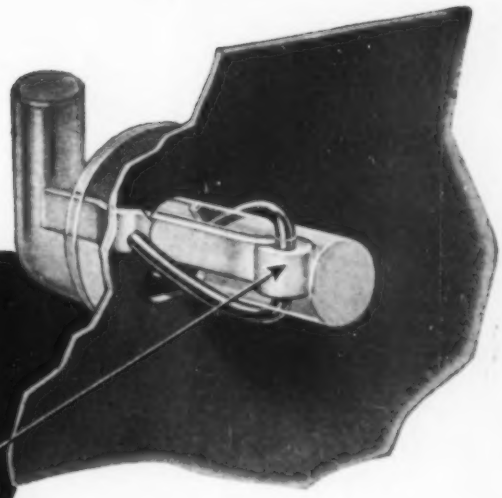
The large scope of these operations makes it economically practicable for Vickers to develop facilities that would be impossible under other circumstances. As a result, you get more for your money when you buy Vickers Hydraulic Equipment.

VICKERS
Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.
Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND • DETROIT HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER ROCKFORD • SEATTLE • TULSA • WASHINGTON • WORCESTER

6394

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

The ONLY plastic shelf support with the heart of steel



This steel insert, molded into plastic Spring-Locks, gives strength where it's needed—at the point of load or impact—eliminates doubts concerning the strength of plastic at these critical points. The metal insert increases the load-carrying capacity of the entire assembly.

The design flexibility of plastic Spring-Locks makes them ideal for a variety of applications. Shelf supports, washer cover knobs, drawer pulls and many other products made by such companies as Frigidaire, Philco, Easy Washing Machine and International Harvester have utilized the combination of utility, beauty and strength these versatile fasteners provide.

Spring-Locks cut material and assembly costs, too. No special tools, bolts, nuts or threadings required. Just a half-turn locks them securely, another quarter-turn and they're free.

Many standard shapes and sizes of Simmons Spring-Locks are available from stock—or any shape head can be designed for your individual needs. Whatever your fastening problem, we'll be glad to help you solve it. Why not send us the details, or call in a Simmons engineer today?

Any shape head can be molded for use as refrigerator shelf supports, lifter knobs, brackets, etc.

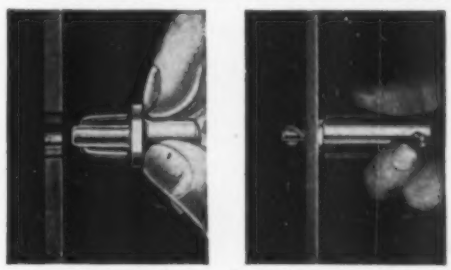
SIMMONS FASTENER CORPORATION
1751 NORTH BROADWAY, ALBANY 1, NEW YORK

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCKS WORK



1. Insert Spring-Lock *2. A half-turn and it's locked*
The steel insert carries the load.

Send for more data and Free Samples today.

put 43 years of experience to work for you...

DIE CASTINGS BY STEWART

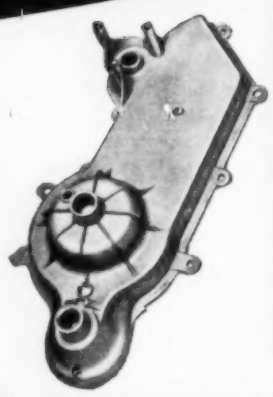
Services Available

Designing • Engineering

Die Making • Metallurgical Control

Most Modern Die Casting Equipment

Complete Machining, Polishing and Assembly Facilities



...for maximum strength, greater wear resistance, and ease of machining.

Stewart DIE CASTING

A DIVISION OF... STEWART SW WARNER

CHICAGO, ILL., 4535 FULLERTON AVE....BRIDGEPORT, CONN., 275 WARREN ST.

NOW CELENAMEL IS AVAILABLE IN SIZES #40 TO #48

MAGNET WIRE THAT CUTS YOUR PRODUCTION COSTS!

No stripping problem. Celenamel Film removed when dipped in solder. Large economies effected in your production. New facilities make Celenamel available now in sizes 40 to 48.

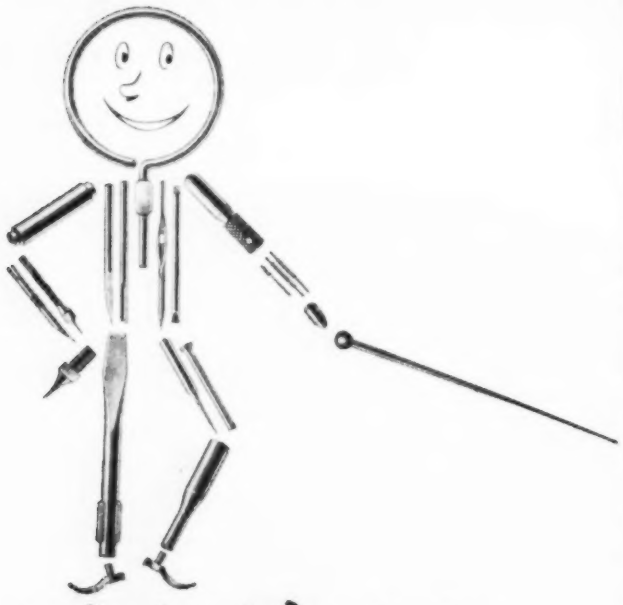
OVER 50 YEARS *Wiremaker for Industry*

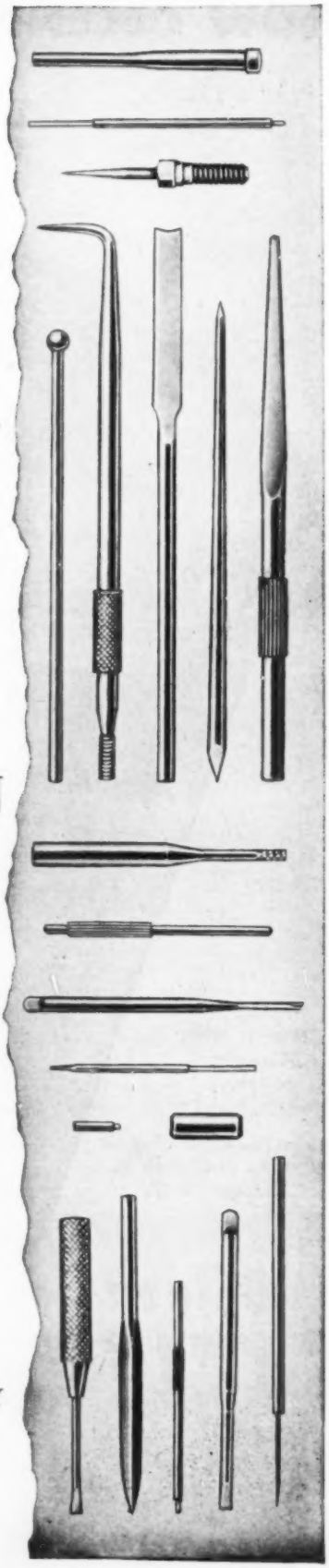
Belden Manufacturing Co.
4691 W. Van Buren St.
Chicago 44, Ill.

Belden CELENAMEL ✻

✻ TRADEMARK REGISTERED

Belden
WIREMAKER FOR INDUSTRY

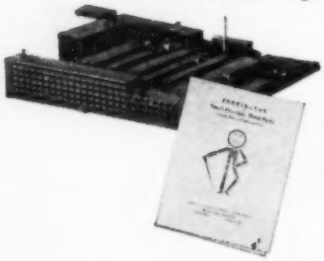




A Wide Variety

of small precision metal parts from a single source...TORRINGTON

Whether you make toys, textile machines or tommy guns, if your products use small precision parts like pins, shafts, pivots, mandrels, punches or knives, TORRINGTON can make them quicker, better and for less than you can. Send your blueprints or a sample part for a prompt quotation. Eighty-six years of precision metal working assures you fine workmanship, prompt delivery, low prices.



Get This Handy Guide to Small Metal Parts!
Torrington's Condensed Catalog shows many typical parts that can be produced to your specifications in any metal. Write for your free copy today.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

Makers of
TORRINGTON NEEDLE BEARINGS

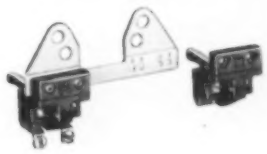
EXTRA AUXILIARY CONTACTS

for ALL Allen-Bradley Starters . . . Sizes 0 to 7

Auxiliary Contacts—Sizes 0 & 1

NOW . . . it's easy to add auxiliary contacts to A-B solenoid starters to operate extra relays, pilot lights, or other accessories. Just follow the steps shown below.

Bulletin 895 auxiliary contacts come in forms to fit all sizes of starters . . . with either single pole normally open, normally closed, or normally open-normally closed contacts. They can be added to any A-B starter in stock or in service.



Auxiliary Contacts—Sizes 2 & 3

ADD ONE OR TWO AUXILIARY CONTACTS TO ANY A-B SOLENOID STARTER

Bulletin 709 Size 0 starter with auxiliary lock-in contact

Bulletin 709 Size 0 starter with one extra auxiliary contact

Bulletin 709 Size 0 starter with two extra auxiliary contacts

SIZE 0 STARTER

One or two extra auxiliary contacts can be mounted on Size 0 arc hood. Terminals are easily accessible from front. Rugged—simple—trouble free.

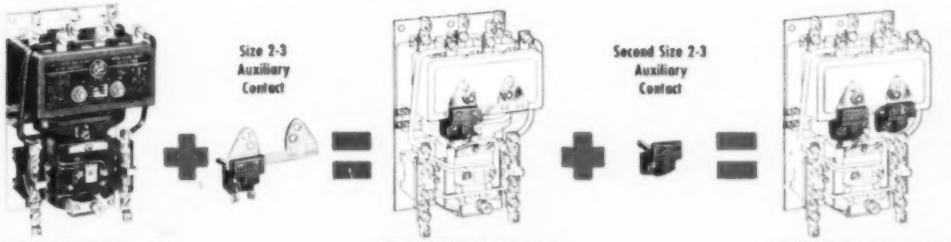
Bulletin 709 Size 1 starter with auxiliary lock-in contact

Bulletin 709 Size 1 starter with one extra auxiliary contact

Bulletin 709 Size 1 starter with two extra auxiliary contacts

SIZE 1 STARTER

One or two extra auxiliary contacts can be mounted on Size 1 arc hood. Terminals are accessible from front. Existing wiring not disturbed in any way.



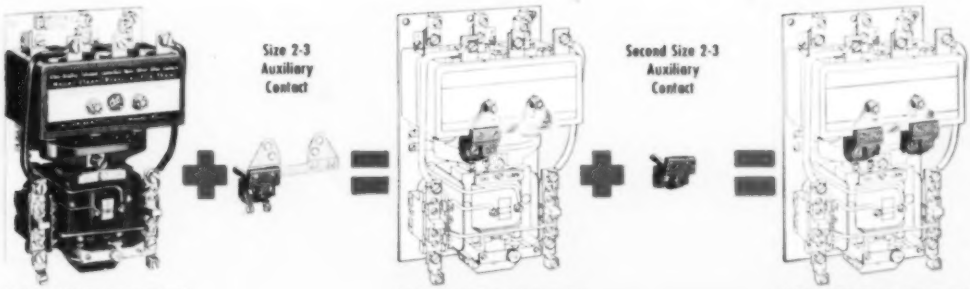
Bulletin 709 Size 2 starter with auxiliary lock-in contact

Bulletin 709 Size 2 starter with one extra auxiliary contact

Bulletin 709 Size 2 starter with two extra auxiliary contacts

SIZE 2 STARTER

Mounting plate will hold one or two extra Size 2-3 auxiliary contacts. It is attached to starter using existing arc hood threaded studs and lock nuts. Solenoid plunger of starter actuates the auxiliary contacts.



Bulletin 709 Size 3 starter with auxiliary lock-in contact

Bulletin 709 Size 3 starter with one extra auxiliary contact

Bulletin 709 Size 3 starter with two extra auxiliary contacts

SIZE 3 STARTER

The Size 2-3 mounting plate will also fit the Size 3 arc hood and support one or two auxiliary contacts. Easy to install and simple to operate. Trouble free performance is guaranteed. No contact maintenance.

Contact arrangements are readily changed from normally open to normally closed, or vice versa. This flexibility opens new possibilities for applying Allen-Bradley contactors and starters to automatically controlled equipment.

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.

A-B Quality

ALLEN-BRADLEY

MOTOR CONTROL

8-53-MR

MAKE YOUR OWN TERMINAL STRIPS

with these handy

BULLETIN 892 TERMINAL BLOCKS

EASILY MADE UP IN ANY LENGTH TO MEET YOUR TERMINAL STRIP SPECIFICATIONS

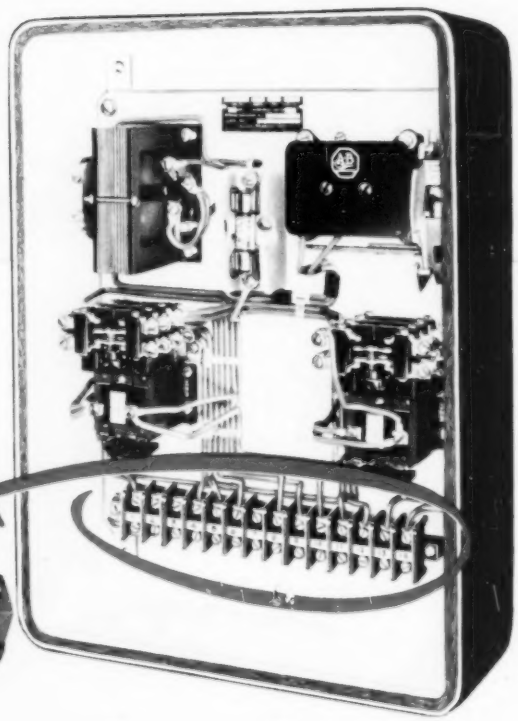
Bulletin 892 terminal blocks interlock in perfect alignment to provide the exact number of terminals for any panel board. There are no excess terminals—hence, no waste of panel space. The required terminal strip can be assembled quickly and mounted on the panel with hold-down bolts. Plastic barriers separate the clamp-type terminals which have lock washers.

One end block and any number of terminal blocks may be hooked together. In general, every 13th block is used to secure a long terminal strip to the panel.

AVAILABLE IN TWO CURRENT RATINGS
15 AMPERES—25 AMPERES

Dimensions of Bulletin 892 Terminal Blocks

Ampere Rating	Width	Height	Over-all Length of 10 Blocks
15	1½"	1"	7"
25	1⅞"	1⅛"	8⅛"



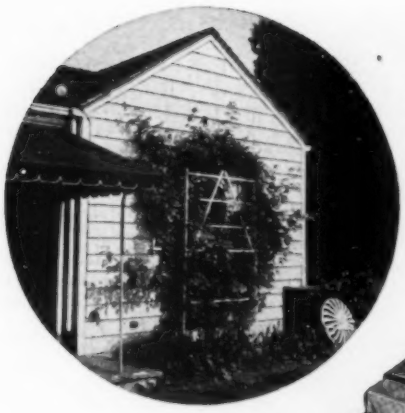
INTERLOCKING TERMINAL BLOCKS

ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

A-B Quality

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.

8-53-MR

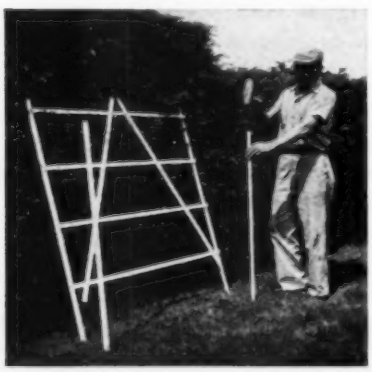


Bethlehem Cold-Formed Channels — future garden trellises — are supplied cut to length and punched. The manufacturer paints the steel shapes and assembles them with accessories into lightweight packages.

STURDY Long-Lasting TRELLISES made from Cold-Formed Shapes

An adjustable steel trellis, made from Bethlehem Cold-Formed Shapes, is currently being manufactured by a leading supplier of metal products for gardeners.

Made from punched, cut-to-length steel channels, the trellis kit, which comes knocked down, contains eleven separate pieces. About 30 variations can be made from one kit, and by combining several kits the trellis can be extended to any desired width.



The use of these cold-formed steel channels allowed this manufacturer to give his customers a better product: longer-lasting trellises, strong enough to support heavy vine loads, and resistant to rot.

At the same time the manufacturer's operations are simplified by using cold-formed shapes. Shop time is saved. The shapes, supplied to the exact dimensions needed, are assembled readily and leave no waste material. They are relatively free of scale, rust or roughness.

Cold-Formed Shapes in Your Product

No matter what you manufacture, there is an excellent chance that you could use Cold-Formed Shapes to advantage in your product. The possible applications of these shapes are almost limitless—lately we've made them for use in overhead door track, ornamental railings, lawn furniture, storage racks, and industrial conveyor systems, to name only a few.

Bethlehem Cold-Formed Shapes come in any gage of strip, sheet or plate steel, from 5 to 24. Your rough sketch will enable our engineers to advise you as to the benefits you could derive through using these shapes. A request to the nearest Bethlehem sales office will bring you our booklet on Cold-Formed Shapes. Or better still, have our representative visit you and discuss Cold-Formed Shapes and their advantages in detail.

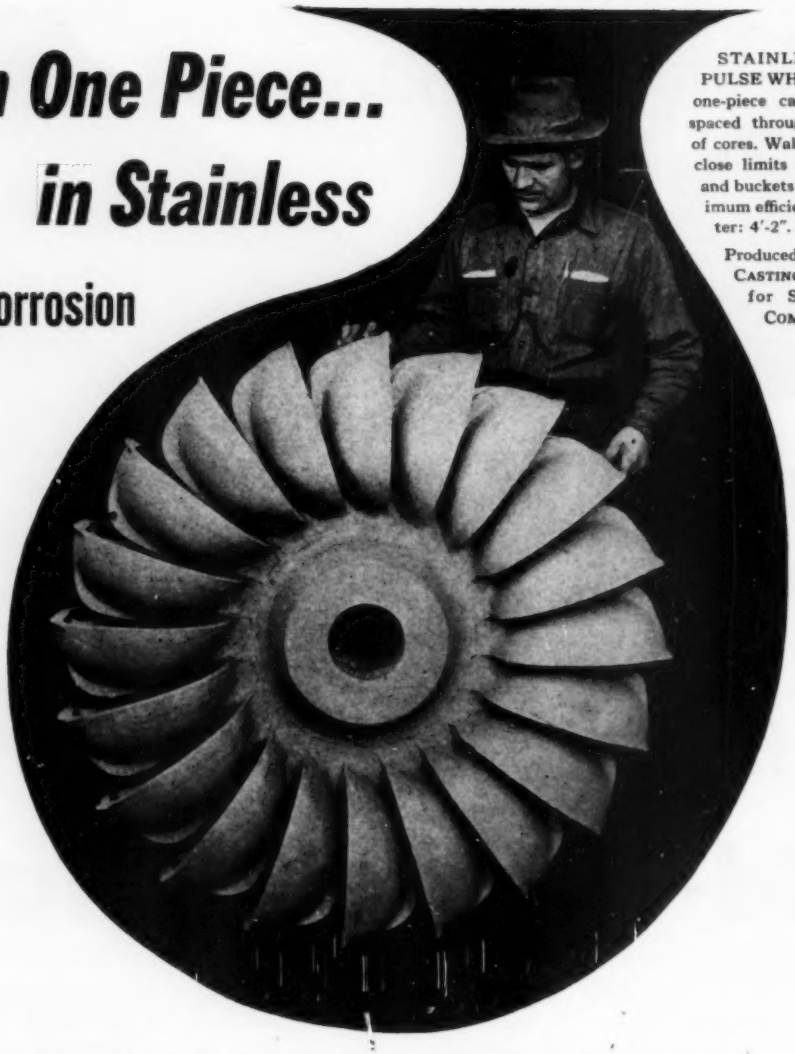
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Cast in One Piece... in Stainless

to resist corrosion



STAINLESS STEEL IMPULSE WHEEL. Buckets in this one-piece casting are accurately spaced through proper alignment of cores. Wall sections are held to close limits to maintain balance, and buckets are polished for maximum efficiency of wheel. Diameter: 4'-2". Weight: 2200#.

Produced by EMPIRE STEEL CASTINGS, INC., Reading, Pa., for S. MORGAN SMITH COMPANY, York, Pa.

Corrosion meets its master in this impulse wheel of cast austenitic stainless steel containing 19 percent chromium and 9 percent nickel...

Furthermore... in hydroelectric power generation, under the terrific impact of a "high head" of falling water... this *stainless* casting tends to work harden while putting water to work, thereby improving its resistance to erosion and abrasion.

Impulse wheels are only one of countless applications in which advantage may be taken of the various useful properties of chromium-nickel stainless steels.

You can trim bulk and deadweight by specifying correct types of stainless. Strong and tough, stainless steels resist wear and attack by nearly all oxidizing acid conditions. Moreover, complexity of design is not a limiting factor in casting chromium-nickel stainless.

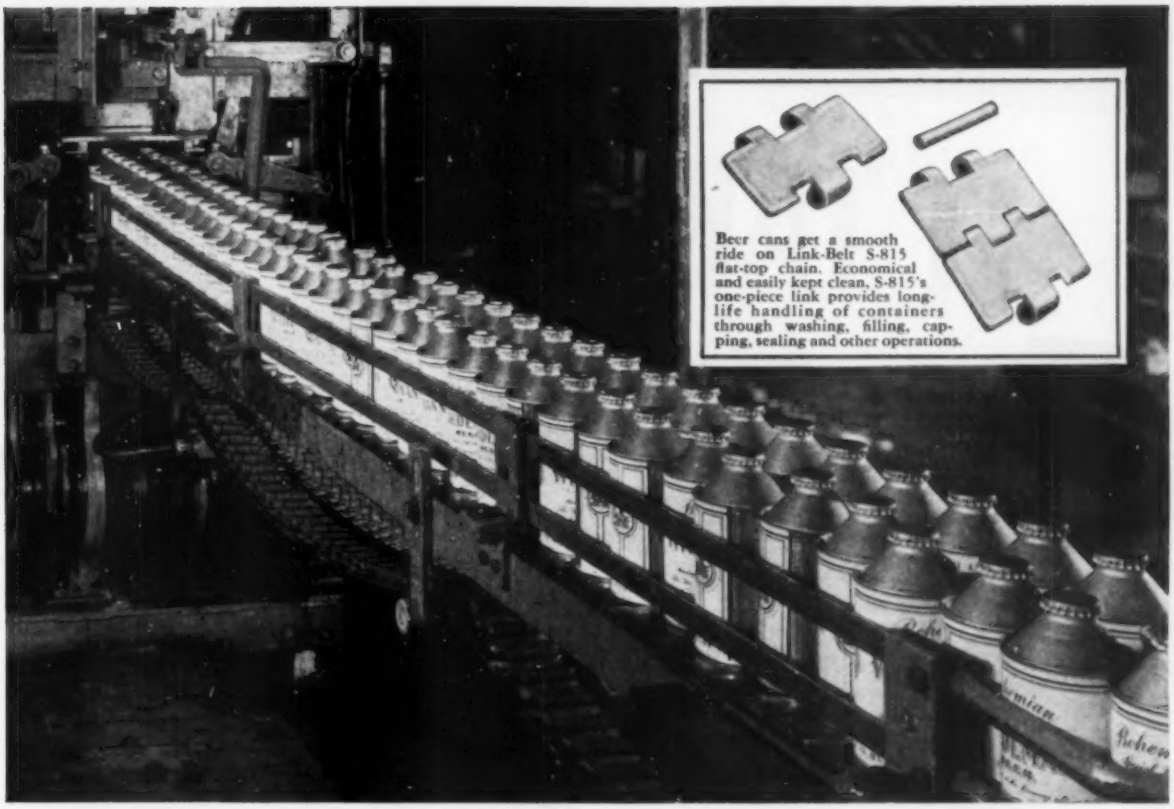
Austenitic stainless steels resist creep, scaling and oxidation at elevated temperatures. And at sub-zero temperatures, they offer exceptional resistance to impact.

Investigate all the economies you may obtain by using stainless steel equipment. Send us your inquiries on the use of cast or wrought stainless alloy steels. Write us details of your problems for our suggestions.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.



Beer cans get a smooth ride on Link-Belt S-815 flat-top chain. Economical and easily kept clean, S-815's one-piece link provides long-life handling of containers through washing, filling, capping, sealing and other operations.

Here's a smooth-operating, flat-top conveyor chain... moderately priced

LINK-BELT offers the chain that's best for every job

THE many varied drive and conveying jobs performed by chains and sprockets require different physical characteristics. The S-815 flat-top conveyor chain is an example of how Link-Belt builds a type and size for every purpose.

In addition, every chain in the complete Link-Belt line is built for longer life. Rigid control of raw materials and manufacturing processes is your assurance of uniformity.

For all the facts on S-815 flat-top conveyor chain, ask for Folder 2344. And for information on the complete Link-Belt chain line, see your nearest Link-Belt district sales representative.

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia). Sales Offices in Principal Cities.

LINK-BELT

CHAINS AND SPROCKETS

13,319

No one chain serves every purpose . . . get the RIGHT one from Link-Belt's complete line

Class RC crescent flat-top chain—travels in horizontal planes, around corners; ideal for bottles and cans.

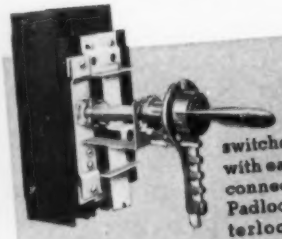
Malleable roller chain for conveyors or inclined elevators where reduced chain pull is desired.

Class 400 swivel chain—carries cartons, cases, etc. over paths with both vertical and horizontal turns.

Class RC flat-top chain—precision made for smoothest, spill-free carrying and long life.

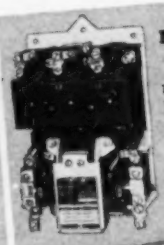
Class RC universal crescent flat-top chain can be used for multiplane operation traveling variety of paths.

IT TAKES ALL 3 for



DISCONNECTS

Heavy duty industrial switches or circuit breakers, with easily installed safety disconnect handle mechanisms. Padlocking provision, and interlocking with door, safeguard personnel.

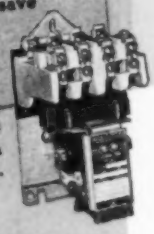


MOTOR STARTERS

Known throughout industry for maximum reliability and accessibility. Easily attached electrical interlocks save space and cost of separate relays.

CONTROL RELAYS

Compact without sacrifice of accessibility, wiring ease or reliability. 2 to 8 poles, convertible from normally open to closed.



TIMING RELAYS

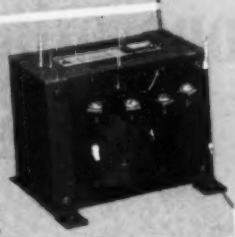
Accurately timed delay periods assure proper machine sequencing. Rugged pneumatic timers give consistent performance over several millions of operations.

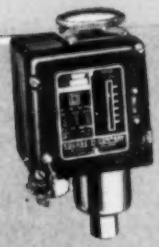
1 a COMPLETE line of components . . .

You can meet virtually any AC or DC application need by using standard Square D components. Each is designed to perform a specific control function—in minimum space—with maximum accessibility for easy inspection and maintenance. Each is physically proportioned for efficient and compact combination with other Square D components in building better, more attractive control panels.

CONTROL CIRCUIT TRANSFORMERS

Good transformer regulation maintains stable secondary voltage, even when energizing large solenoids or magnetic devices. New sizes extend range to 1000 VA.





PRESSURE SWITCHES

Adjustable pressure ranges from 1 to 3000 P. S. I. Drip-tight, oil-resistant enclosure houses sturdy mechanism and S. P. D. T. electrical contacts.

PUSHBUTTONS & ENCLOSURES

Heavy duty, oil-tight pushbuttons, selector switches and pilot lights in attractive cast enclosures harmonize with machine contours.

LIMIT SWITCHES

Compact enclosures exclude oil and dust. Easily adjustable operating arms and accessible terminals simplify installation.

DRUM SWITCHES

Attractively styled, compact case enhances appearance of machine. Switch is easily convertible from maintained contact to spring return.

NEW!

SQUARE D COMPANY

DESIGN LEADERSHIP IN MACHINE TOOL CONTROL

Engineered, Factory-Assembled and Tested by

SQUARE D COMPANY

2 Field Engineering . . .

Through seasoned Field Engineers, headquartered in more than 50 principal cities, Square D works "hand-in-glove" with machinery builders and plant engineers in solving electrical control problems. You'll like to work with them. They talk your language. They're backed by thorough factory engineering to assure the best possible selection of circuits and components.

3 Factory Assembly and Test . . .

No other electrical control manufacturer offers such complete and flexible facilities for designing and building custom equipment. If you don't have the complete story of Square D's new Job Shop operation, mail the coupon and we'll send it to you promptly.

SQUARE D COMPANY, Dept 81
4041 N. Richards Street, Milwaukee 12, Wis.

Please send me a copy of your new booklet which gives the complete story of Square D's new **JOB SHOP OPERATION.**

Name _____

Address _____

City _____ Zone _____ State _____

with pardonable pride, we consider ourselves

Tube Specialists

Come to Wolverine for ALUMINUM TUBE as well as Copper Tube

When you buy Wolverine aluminum tube you will do so with the same confidence that you have in buying Wolverine copper tube. That's because our aluminum tube is produced under the same top quality control that has brought distinction to our copper tube through our 36 years of tube manufacturing.

This tube lends itself most admirably for use in making television antennas and many types of indoor and outdoor furniture. It is also applicable in the refrigeration industry for suction lines.

This tube is made from 2S and 3S aluminum in standard sizes from ¼" thru 2" O.D., in wall thickness ranging from .020 thru .180. We are well equipped to meet your particular specifications.

In addition to plain aluminum tube, Wolverine also manufactures aluminum finned tube either in all aluminum or in bi-metal. It is known as Wolverine Trufin* and is especially suited for effective heat transfer. In bi-metal—Trufin combines the advantages of all-aluminum integrally finned tube with a liner of copper or a copper base alloy on the inside. (Of course, Trufin is also available in all-copper, copper base alloy, 1010 welded steel, and type 304 stainless steel.)

Trufin is available in 5 fins, 7 fins, 9 fins, 11 fins, 16 fins, and 19 fins per inch, with outside fin diameters ranging from ½" to 2".

Call your nearest Wolverine Sales Representative now to help you select the proper aluminum tube to meet your needs.

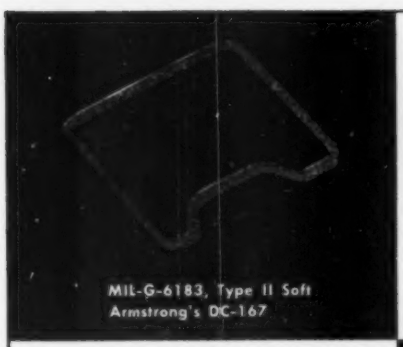
*REG. U.S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing
1415 CENTRAL AVENUE • DETROIT 9 MICHIGAN

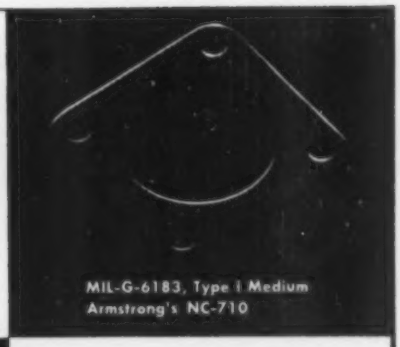
ESTABLISHED 1916

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*



MIL-G-6183, Type II Soft
Armstrong's DC-167

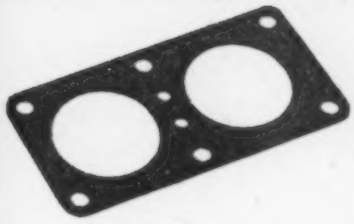
MIL-G-6183, Type I Firm
Armstrong's NC-711



MIL-G-6183, Type I Medium
Armstrong's NC-710

MIL-G-6183, Type II Medium
Armstrong's DC-100

MIL-G-6183, Type II Firm
Armstrong's DC-113

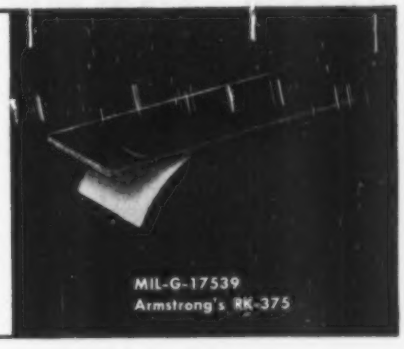


MIL-G-6747
Armstrong's DK-149

These nine different materials meet most government specs for cork-and-rubber gaskets

MIL-G-6183, Type I Soft
Armstrong's NC-709

MIL-T-6841
Armstrong's DK-153 and RK-3048



MIL-G-17539
Armstrong's RK-375

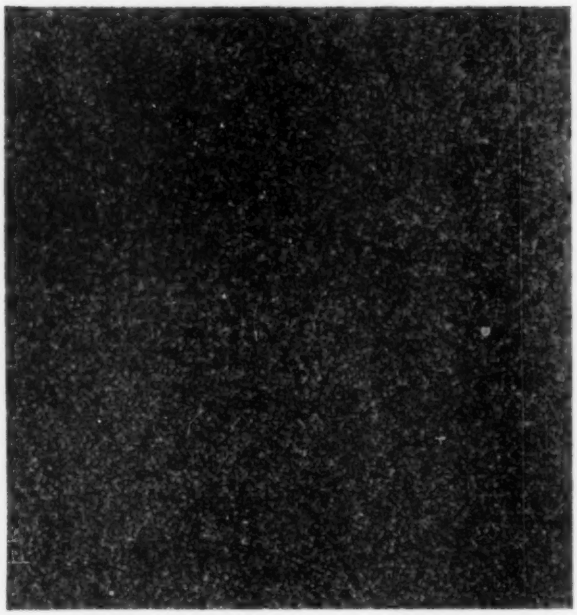
When you need a cork-and-rubber gasket to meet government specifications, check with Armstrong. Each of the Armstrong materials shown above is made to meet one of the nine principal specifications for cork-and-rubber gaskets. Sheets and tapes are available immediately from stock, parts cut to your order take only a little longer.

For samples and full information, call your nearest Armstrong Industrial Division Office or see the "Armstrong's Gasket Materials" section of Sweet's product design file.

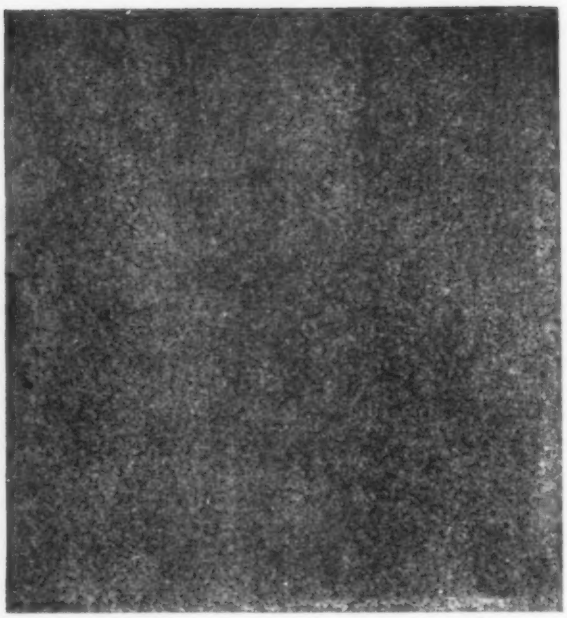
Free gasket data book. Send for a free copy of the new 1953-54 edition of "Armstrong's Gasket Materials" for your file. It's packed with useful information: contains current government specs, tentative SAE-ASTM specs, plus sections on cost reduction, gasket tolerances, flange design, etc.

For your free copy, write to Armstrong Cork Company, Industrial Division, 7110 Irvin Street, Lancaster, Pennsylvania.

Armstrong's Gasket Materials



When plain carbon steel is exposed to the atmosphere, it begins to oxidize almost immediately and a layer of rust forms over the surface. After a brief period this rust has a tendency to curl up and flake off, leaving the metal exposed to further corrosive action.



Corrosion also takes place when Mayari R is exposed to the atmosphere. But the rust is different. Instead of flaking, it forms a thin, tight coating that holds securely to the surface and retards further corrosion of the metal beneath. And this in turn means longer life for Mayari R.

Why Mayari R Has Longer Life than Plain Carbon Steel

Tests conducted over a 10-year period show that Mayari R has 5 to 6 times as much resistance to atmospheric corrosion as plain carbon steel—and 2 to 4 times as much as copper-bearing steel.

During the first year of exposure under these tests, each of these three metals lost practically the same amount of weight through corrosion. But following that initial loss, the corrosion of the Mayari R gradually slowed down. After a few years it appeared to stop altogether. The plain carbon steel and the copper-bearing steel, on the other hand, continued to rust away and lose weight year after year, with practically no decrease in the rate of corrosion.

Mayari R has other advantages. It has better abrasion-resistance, higher yield point, and greater tensile strength than ordinary steel. These properties all contribute to improved design and longer life of equipment and structures.

You can get further information about Mayari R low-alloy, high-strength steel by writing to any of our sales offices for Catalog 259.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

Mayari R *makes it lighter... stronger... longer lasting*

Soften up tough design problems with VINYLITE flexible plastic compounds

BRAND

When you need a flexible material that combines good appearance with long service life—pick VINYLITE Elastomeric Plastics. They're right for so many jobs because

They're FLEXIBLE to almost any degree, from soft and rubbery to semi-rigid . . . withstand long flexing without cracking.

They're HANDSOME . . . color in practically every shade . . . in transparent, opaque, or translucent form with lustrous finish.

They're DURABLE . . . non-fading, abrasion-resistant . . . deliver extra-long service.

They're RESISTANT to oil, most chemicals, corrosive atmospheres, greases, water, alkalies, sunlight, oxidation.

They're ADAPTABLE . . . can be molded in almost any variety of shades, used under a wide range of operating conditions . . . withstand temperature extremes from −67 deg. F. to 140 deg. F.

Learn more about VINYLITE flexible plastic compounds. Send for the illustrated booklet, "VINYLITE Extrusion and Molding Resins and Plastics." It's packed with technical data, typical applications and features such as the sections titled "Suggestions for the Design Engineer" and "Average Properties Tables." For your free copy, write Dept. SF-10.

BETTER HANDLE GRIPS for bicycles, lawn mowers, farm equipment, are molded of VINYLITE Elastomeric Plastics, providing:

• excellent detail and finish • improved wearing qualities • wide range of colors • warm, pleasant "feel" • resistance to water, sunlight, gasoline, perspiration • tight fit on handle.

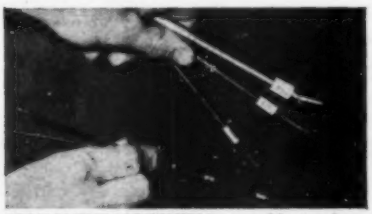
BETTER VACUUM CLEANER PARTS, such as bumpers, elbows and handles, are molded of VINYLITE Elastomeric Plastics to get these features:

• long-lived flexibility • lightweight • colors resistant to fading and bleeding • toughness • superior finish • abrasion resistance.

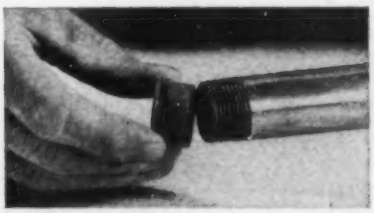
Vinylite
BRAND
PLASTICS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

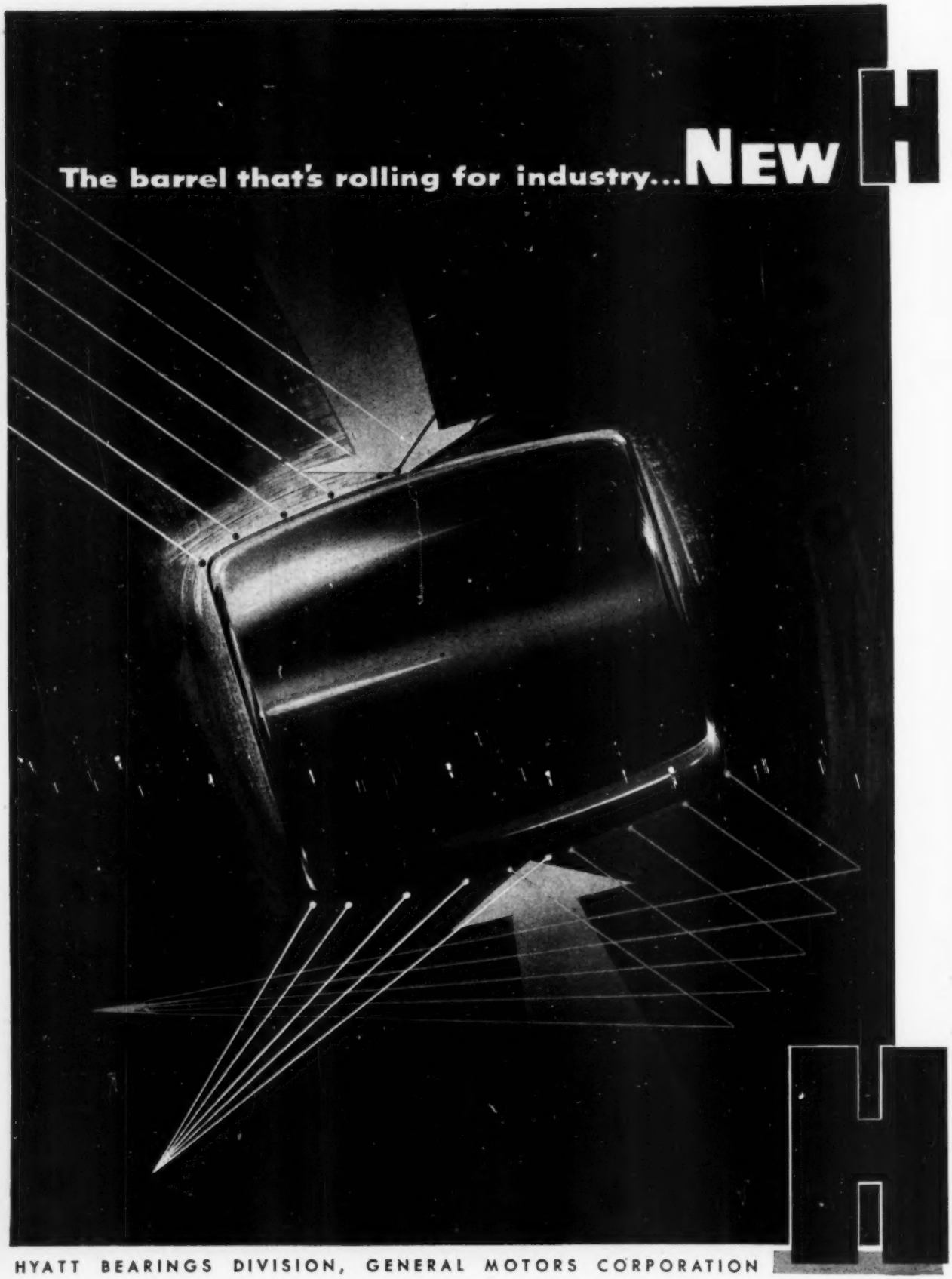


PERMANENT LEGIBILITY is assured by tags laminated of BAKELITE Rigid Vinyl Sheets. Virtually any combination of print and color is available. Polished and "write-on" finishes can be provided on the same tag. By Duramark, Inc., Port Washington, N. Y.



TOUGH, FLEXIBLE caps and plugs, made of BAKELITE *Polyethylene* protect pipe threads, tubing ends, etc., seal out dust and moisture. Applied by pushing in or on both threaded and plain circumferences. By CaPlugs Div. of Protective Closures Co., Inc., Buffalo, N. Y.

HIGHER GLOSS, brighter colors mark food wrappers whose wax coatings contain BAKELITE *Polyethylene* Resins. This wax-resin blending also affords better heat seal, greater tensile strength. Wrapper by Pollock Paper Corp., Dallas, Texas.



HYATT BEARINGS DIVISION, GENERAL MOTORS CORPORATION

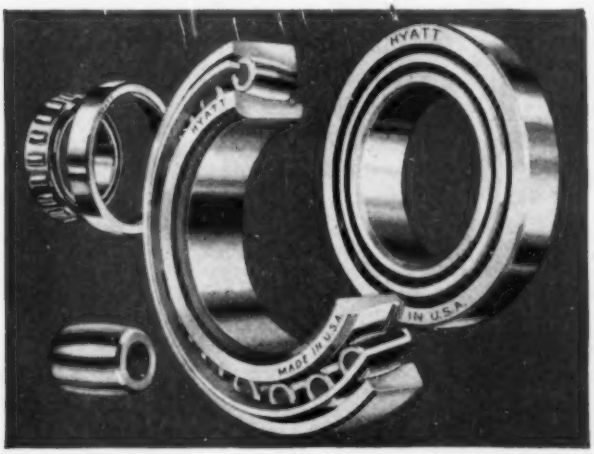
YATT BARREL BEARING

now available in volume!

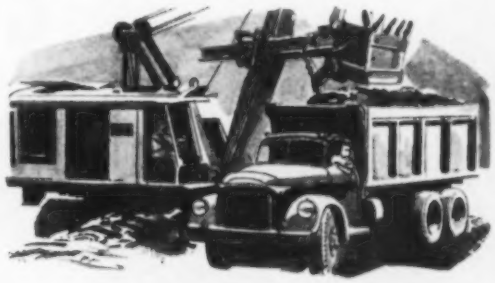
Hyatt is rolling out the barrels! . . . and a familiar shape is giving a big lift to modern industry! A new Barrel Bearing —pioneered and perfected by Hyatt—is available in volume for the first time! There's no other bearing quite like it—and it's ready for a starring role in industrial production!

The Barrel name comes from the barrel shape of the rollers . . . but its superiority in bearing applications comes from *dual-purpose design* and *self-aligning ability!* This unique bearing takes load from any direction . . . and operates at full load-carrying capacity under conditions of misalignment! And in addition, the barrel shape of the rollers combines the low rolling friction of a ball with the high load capacity of a cylindrical roller—so that the Barrel Bearing is ideal for a wide range of applications.

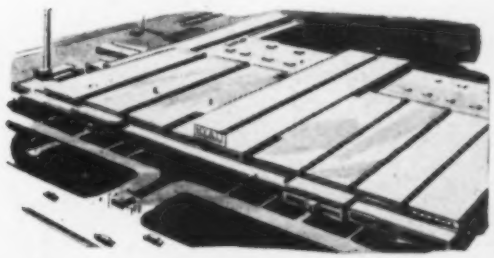
Expensive? *Not at all!* Advanced manufacturing processes —plus the facilities of one of the newest and finest bearing plants in the world—make the initial cost far lower than you would expect! . . . For full information on this newest solution to the friction problem, write to the address below.



Self-aligning action makes the Barrel Bearing ideal for tractors and farm implements. Over many years, its durable, dependable performance has been established in a wide range of these applications.



In trucks and construction equipment, too, Hyatt's Barrel Bearing operates with full efficiency under conditions of heavy, multiple-direction loading. Unique roller and race design distributes the load over large areas of contact.



Hyatt's new plant, in Clark Township, N. J., is among the most modern in the world. New equipment makes possible advanced manufacturing processes, and research facilities are the finest in the bearing industry.

YATT ROLLER BEARINGS

HARRISON, NEW JERSEY

Announcing...

a new service from Ampco

AMPCO* METAL

Grade 24 Die Blanks

now available from stock

LET AMPCO PROVE ITS METAL

Stainless steel kitchen utensils and wash machine tub produced on Grade 24 dies.

Ampco Grade 24 die used in forming 120,000 stainless steel pieces.

...the dies for forming and drawing stainless steels that give longer runs, reduce scrap, cut your costs

This is good news for everyone who makes drawn or formed stainless parts. Now you can get immediate delivery on 70 sizes of solid rounds, rectangles, and centrifugally-cast rings *at new low prices* for your stainless drawing, forming, or bending operations.

Die blanks of Grade 24 Ampco Metal have become so popular that commonly used sizes are now available from Milwaukee stock. Types and sizes include:

34 sizes of solid rectangular pieces from ½" x 1" x 12½" to a maximum of 4" x 4" x 12½".

27 sizes of centrifugally cast blanks from 4" OD x 1" ID x 1½" thick up to 20" OD x 12½" ID x 2" thick.

11 sizes of solid rounds up to 5" OD x 12½" long.

The popularity and wide acceptance of this special alloy for forming or drawing stainless or other "hard-to-work" materials is due to these advantages — advantages you get only with Ampco Grade 24:

1. Your usual scrap losses are minimized because Ampco grade 24 dies are non-galling, non-loading.

2. Less time is required for finishing operations . . . your costs are cut. Grade 24's unique bearing qualities and low co-efficient of friction eliminate scratches and die marks on surface of pieces drawn.

3. You get longer runs without redressing caused by pickup, *longer die life, reduced downtime.* This remarkable alloy gives a die life 3 to 5 times greater than other bronzes and many times that of conventional steel dies.

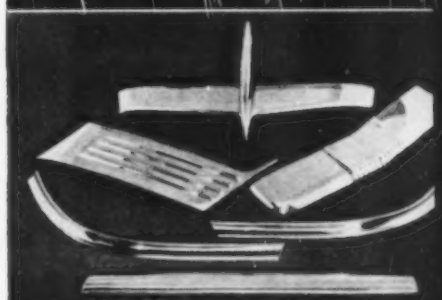
Don't wait any longer to enjoy low-cost, trouble-free production of drawn metal parts. If you draw, form, perform roll forming, or reduce tubes or similar sections — if you use stainless, pickled carbon steel, silver, zinc, lead, or Inconel or Monel metals — Ampco Grade 24 is just right for you. Send the coupon today for complete information and prices.

Mail this coupon today!

*Reg. U. S. Pat. Off.

Pressure pad used with die above.

A group of Ampco dies.



Stainless steel auto trim formed over Ampco Metal Grade 24.

Ampco Metal, Inc.

MILWAUKEE 46, WISCONSIN

WEST COAST PLANT,
BURBANK, CALIFORNIA

Ampco Metal, Inc.

Dept. PE-10, Milwaukee 46, Wis.

Please send me a copy of Ampco Grade 24 stock die folde at no obligation.

Name .....

Title .....

Company .....

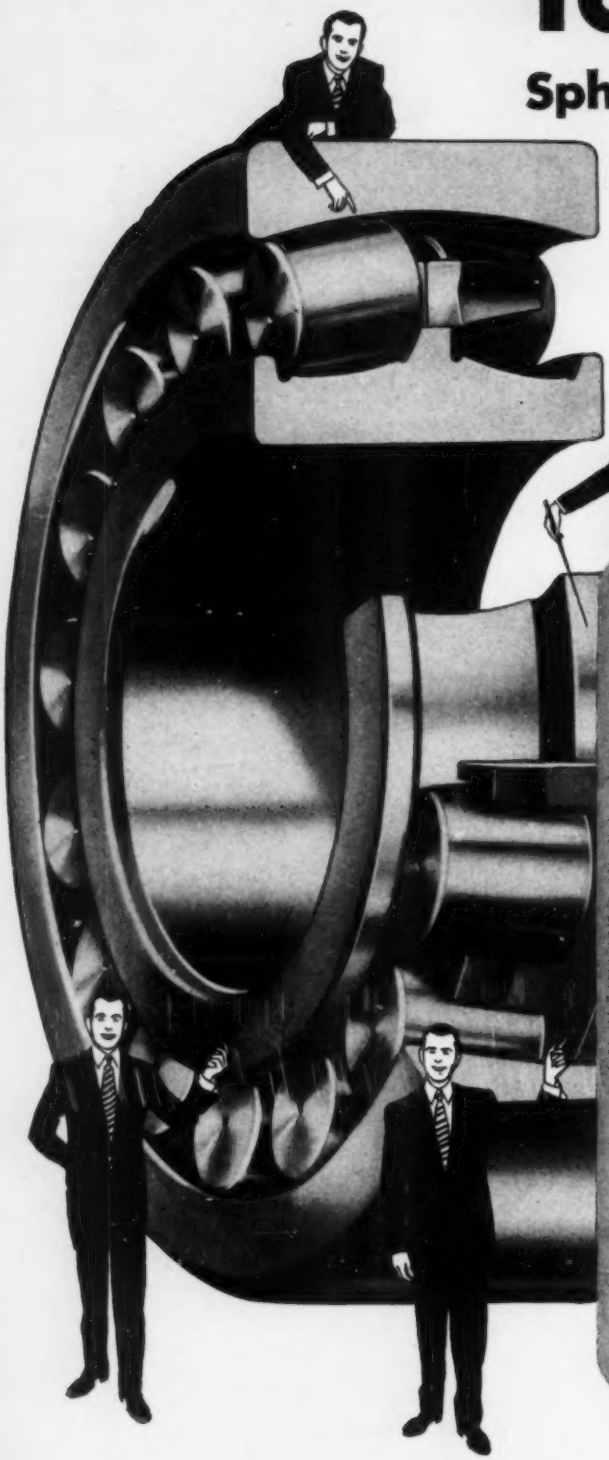
Company Address .....

City ..... (.....) State .....

TORRINGTON

Spherical Roller Bearings

offer you these basic advantages!



- **Accurate geometrical conformity between races and rollers**—for maximum load bearing capacity at all times.
- **Inherent self-aligning feature**—for continuous service and free-rolling even under shock loads and at sustained speeds.
- **All contact surfaces precision ground from the finest of bearing quality steels**—for minimum friction and maximum life under the toughest operating conditions.
- **Races and rollers heat treated according to the most advanced metallurgical procedures**—to insure uniform hardness in all load-bearing parts.
- **Individual one-piece cast-bronze cage for each path of rollers**—to eliminate roller binding and assure freedom of operation.
- **Radial stability provided by land-riding cage and integral flange on inner race**—to give accurate roller guiding.
- **Unit assembly, with sturdy flange and race construction**—for easy, economical handling during installation.
- **Available from stock with either straight or tapered bore**—for shaft or adapter mounting.

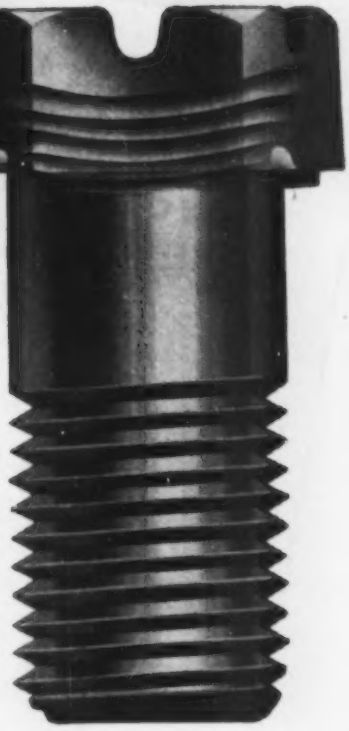
These advantages add up to maximum performance for your bearing dollar. That's why it always pays to specify TORRINGTON Spherical Roller Bearings.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

TORRINGTON SPHERICAL ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

• VIBRATION
• FATIGUE
• IMPACT
• SHOCK



Lamson PLACE BOLTS will solve it

The Lamson Place Bolt answers many fastener problems where vibration is a factor.

Special slots in the head of the bolt plus a circular recess around the under side of the head combine to provide spring or locking action of the head against the tapped material. As the bolt is tightened the segments of the head are forced inward, this flexibility adds to the elasticity of the shank and the locking efficiency of the bolt.

The slotted Place Bolt can carry as much load as a conventional bolt because the shear section of the head is stronger than the tensile stress area of the thread.

HOW PLACE BOLTS MAINTAIN TENSION

It is well known that bridges are constructed to "give" when encountered by high-velocity winds and that the strongest buildings are not rigid in construction, even successful boxers learn to roll with the punch. This same principle governs the design of the Place Bolt.

The flexible area between the slotted segments in the upper face of the bolt head and the recess adjacent to the shank in the lower face acts as a controlled spring element. The amount of "spring" is in proportion to the wrenching torque applied.

Tension is maintained because the elastic flexing of the head, added to the overall elastic elongation of the shank, permits greater loss in clamping distance before tension drops to zero. At the same time, ability to resist shock is greatly enhanced by the added elasticity.

For the whole story, send for the Lamson Place Bolt folder.

Lamson & Sessions

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

FOR PROMPT DELIVERY AND HELPFUL SERVICE, ORDER FROM YOUR LAMSON DISTRIBUTOR

PLUG NUTS — Ideal for blind or hard-to-reach places.

PIPE PLUGS — Forged steel, heat-treated.

"1035" SET SCREWS — Cup point type, hardened and heat-treated.

PLACE BOLTS — With "Built-in" spring action for positive locking.

LOCK NUTS — Economical, vibration proof. Can be used repeatedly.

"BENT BOLTS" — Including U bolts, eye bolts, hook bolts, etc.

MACHINE SCREWS — Clutch and Phillips recessed head screws.

SEMS — Pre-assembled lockwashers on tapping and machine screws.

BUILT-IN

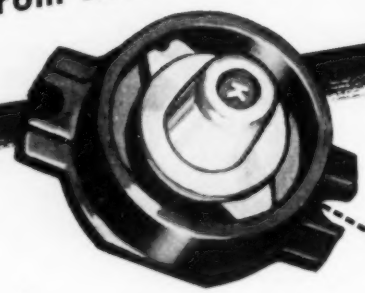
KLIXON

MOTOR PROTECTOR

Safe Guards

"IN-SINK-ERATOR"

from Motor Burnouts



"In-Sink-Erator" food waste disposer eliminates one of the messy kitchen problems faced by the housewife by having the garbage go down the drain. It is easily installed in sinks, safe to use.

One of the first garbage grinder manufacturers to use Klixon Protectors, In-Sink-Erator Mfg. Company, has used Klixon Manual Reset protectors in their disposer since 1946. The reason — experience proves that these protectors can be depended on to provide protection against motor burnouts, thus assuring trouble-free operation for years on end.

You, too, can keep your motors operating longer, reduce service calls and repairs by specifying and using Klixon protected motors. The additional cost is exceptionally low, pays for itself in customer goodwill by reducing motor burnouts.

KLIXON *Thermo Snap* TEMPERATURE CONTROLS

Actuated by the snap-acting Spencer Disc, these controls open the circuit with a quick, clean break; close with a solid make. Their accurate operation withstands shock, vibration, motion and altitude. Used in military and commercial applications ranging from tanks, aircraft, sterilizers, radio and electronic equipment to household appliances. Available in many types and ratings including hermetically sealed units.

KLIXON

TRADE MARK REG. U.S. PAT. OFF.

SPENCER THERMOSTAT

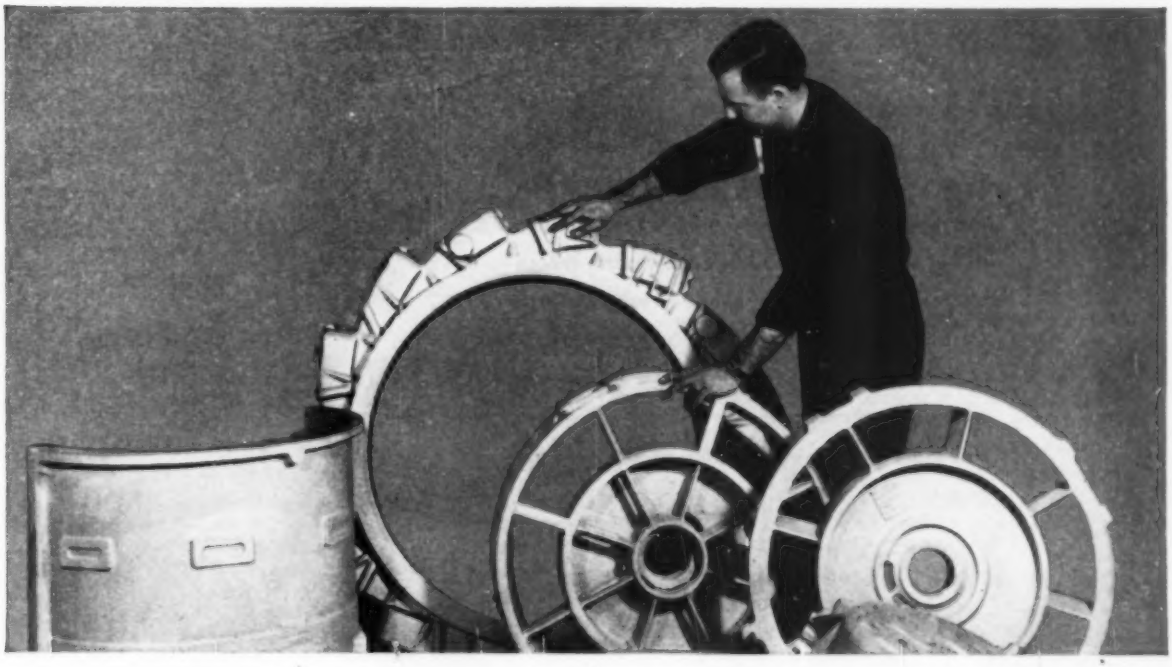
Division of Metals & Controls Corporation

910 FOREST STREET, ATTLEBORO, MASS.

DOW

LIGHTER, MORE RIGID CASTINGS MADE WITH DOW MAGNESIUM

Production economies also offered by sand and permanent mold castings



Lighter, yet more rigid castings! That's the big advantage of magnesium in sand and permanent mold castings.

By increasing section thickness and adding stiffening ribs, greater rigidity is possible. And because of magnesium's high strength to weight ratio, total weight can be cut.

Magnesium also offers outstanding production advantages. Chief among these is magnesium's excellent machinability. There are many instances where time saved in machining has lowered the cost of the finished part beyond that of any other metal. Cutting tools last longer; replacement costs and downtime for sharpening and resetting are reduced.

Look, too, at the cost saving possible in handling. Magnesium's lightness can cut the costs of shipping, from raw casting to finished product. In-plant materials handling costs can also be reduced appreciably when lighter castings are used.

For further information on the advantages of magnesium, contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, *Magnesium Department*, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW

From Design... To Delivery

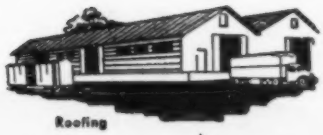
...ng Metal Stamp...

Wire forming, metal stamping or deep-drawing, every Eastern Tool & Mfg. Co. job begins in our design and tooling department, where experienced department heads prepare production plans and specifications on the necessary tools and dies. From design to delivery every job remains under close supervision, another reason why we have grown over the years.

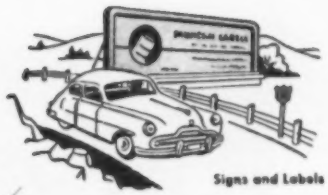
Write for Bulletin No. 100, the story of the background and services of Eastern Tool & Mfg. Co.

Eastern Tool & Mfg. Co.

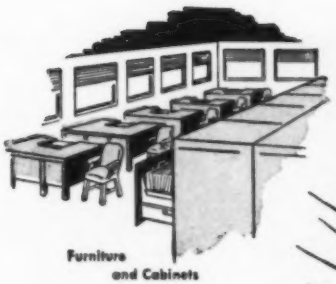
Belleville 9, New Jersey



Roofing

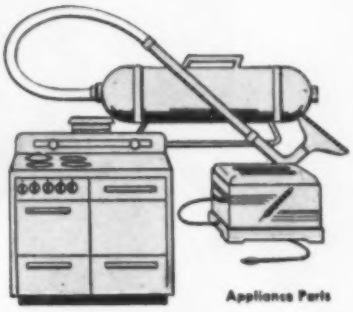


Signs and Labels

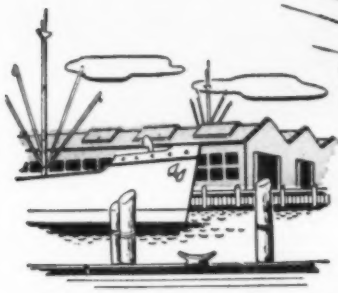


Furniture and Cabinets

NEW HORIZONS for ALUMINUM



Appliance Parts



Marine Applications and Many Other Uses

now made possible with **DU PONT VITREOUS ENAMEL**

Get all the advantages of aluminum— in colors that help your product sell better

EASE OF FABRICATION

WIDE COLOR APPEAL

DURABILITY

INCREASED STRENGTH

EASE OF APPLICATION

The remarkable properties of Du Pont vitreous enamel for aluminum permit a new, wider use of lightweight aluminum alloys. This outstanding protective finish enables you to take advantage of aluminum's desirable features in a variety of structural and decorative applications. And Du Pont vitreous enamel adds a wide color appeal to your household and industrial products—gives them another important sales advantage.

Vitreous enameled aluminum can be sheared, sawed, drilled and punched without damage to the coating. Costly prefabrication is eliminated because standard size enameled sheets can be cut to size on the job.

Almost unlimited range of colors and degrees of surface gloss available . . . can be produced in multi-color effects by masking, spray or screen stencil processes.

Du Pont vitreous enamel for aluminum is lightfast . . . displays excellent resistance to corrosion, abrasion, thermal shock, impact and flexing . . . has a high dielectric strength.

A standard thickness coating of vitreous enamel increases the rigidity of sheet aluminum as much as 60%!

Vitreous enamel is readily applied by ordinary enameling and firing procedures.

FOR MORE INFORMATION SEND FOR YOUR FREE COPY OF THIS BOOKLET

Vitreous enamel for aluminum is fully described in this free booklet—just fill out and send in the coupon below.

DU PONT
VITREOUS ENAMEL
FOR ALUMINUM

DU PONT

BETTER THINGS FOR BETTER LIVING
...*THROUGH CHEMISTRY*

E. I. du Pont de Nemours & Co. (Inc.) PE-103
Electrochemicals Department, Wilmington 98, Delaware

Please send me a free copy of your booklet on Du Pont Vitreous Enamel for Aluminum. I am interested in enameling the following types of work_____

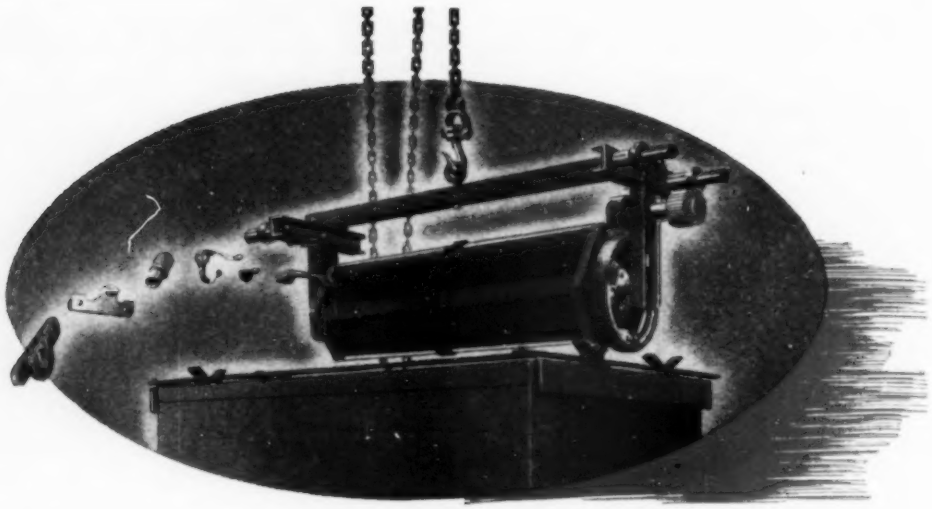
_____

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____



Plating on Aluminum made EASY with Alumon*

Hundreds of manufacturers throughout the United States are now using electroplated aluminum. The Alumon process is simple. The work is merely cleaned, dipped in acid, dipped in Alumon and is then ready for electroplating with copper, nickel, and other metals. The process is suitable for plating most wrought and cast alloys. . . The cost of using Alumon is low, being less than half a cent per square foot of surface area treated. The process can be fitted easily into regular plating cycles. Bulk or barrel plating readily done. Upon request we'll gladly send you the Alumon Process Bulletin.

Write for literature on Alumon and check list of literature on sixty Enthone products and processes for better metal finishing.

*TRADE-MARK REG. U. S. PAT. OFF. MANUFACTURED UNDER U. S. PATENT 2,142,564.

METAL FINISHING PROCESSES

ENTHONE
INCORPORATED
442 ELM STREET
NEW HAVEN, CONNECTICUT

ELECTROPLATING CHEMICALS

AB Breakers pioneer greater capacity— smaller size

Always the leader in better-engineered circuit protective devices, Westinghouse sets a new pace with four compactly designed products that spell more capacity in less space than ever before possible.

The new J Breaker is only 10⅛″ high compared with 15½″ for conventional 225-amp breakers. Saves at least 34% mounting space in panels, switchboards, control cabinets and other enclosures.

The new E Breaker, formerly rated 50 amps, has been redesigned for 100 amps with no increase in size. A panel of 100-amp E's gives the same capacity but saves the price of heavy duty panelboards.

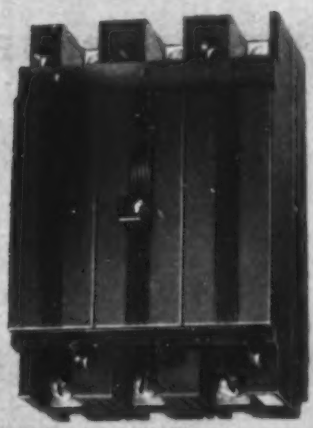
The new Quicklag Plug-in Thermal-magnetic De-ion® Breaker saves 25% mounting space. Plug-in contacts speed assembly. New type terminals end looping of wires.

The new 60-amp Visible Blade De-ion Switch is a fusible or non-fusible disconnect for all types of control panels up to 50 hp, 600 volts a-c. It's smaller, has higher interrupting capacity than any device of comparable rating.

These new products are available now, fully listed by Underwriters' Laboratories, Inc. For complete details call your Westinghouse Representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-30144

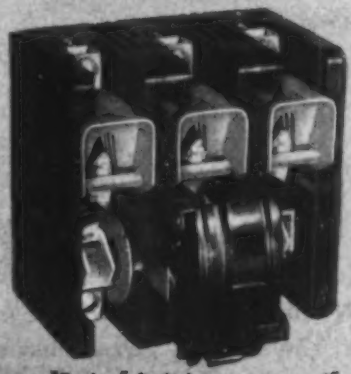
YOU CAN BE SURE...IF IT'S Westinghouse

225 amp J Breaker — saves 34% space

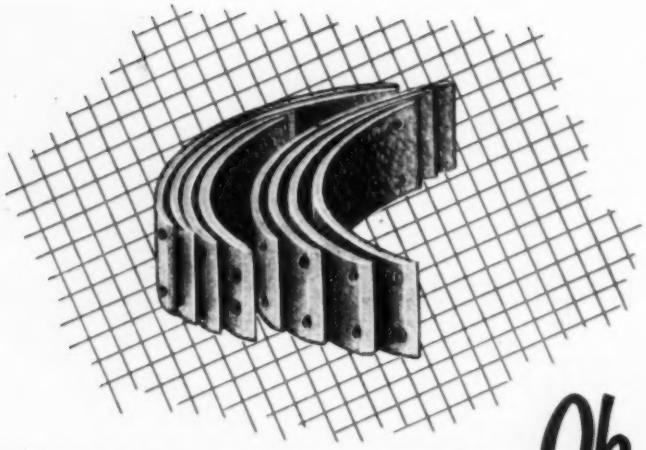


100 amp E Breaker — doubles former capacity

Quicklag Breaker — 25% smaller



60 amp "De-ion" Switch — measures 4" x 4"



BETTER WIRE—BETTER BRAKE LINING? **Oh, YES!**

for Automobiles . . . Trucks . . . Motorcycles

Farm Implements . . . Hoists . . . Tractors

Earth Moving and other Industrial Machinery

REYNOLDS WIRE protects performance

Who makes the brake lining? The answer is important to automotive, agricultural and other industrial users.

Behind each of the wire-lock that appears in the brake lining is a story of progress.

That story is important to you who make or use the brake lining. To those who build brake lining into passenger cars, trucks, buses, farm implements, contractors' and other kinds of machinery. And to the users of those machines.

Because the better the wire, the more dependable and the more uniformly effective the braking. And it prolongs the years and yields us the service life of the lining.

There is no better reinforcement than Reynolds Wire. Every coil is tested for [illegible] and [illegible] controls.

For the automotive and all other "precise specification" industries, Reynolds is made to meet special requirements—by engineers with 50 years' specialized know-how, using the most modern equipment and methods. Consultation without obligation.

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO.
DIXON, ILLINOIS

Divisions of National-Standard Co.

ATHENIA STEEL—*Clifton, N. J.*	Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD—*Niles, Mich.*	Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY—*Jersey City, N. J.*	Metal Decorating Equipment
WORCESTER WIRE WORKS—*Worcester, Mass.*	Round and Shaped Steel Wire, Small Sizes

NS NATIONAL-STANDARD Company NILES, MICHIGAN

PROBLEM:

Obtain a Thermostat Element capable of quickly interrupting a circuit on heavy overloads before the Element becomes dangerously overheated

SOLUTION:

General Plate TRUFLEX® THERMOSTAT METAL with a Magnetic Iron section added solved the problem

A leading manufacturer of Aircraft Circuit Breakers had the problem of obtaining a thermostat element that would interrupt a circuit running up to several thousand amperes. Previous elements didn't move fast enough and became overheated and destroyed on heavy overloads.

General Plate provided the solution with a TRUFLEX thermostat element with a magnetic iron section, butt welded to one end, which provided magnetic assistance to accelerate operation.

General Plate fabricates complete TRUFLEX thermostat metal elements and assemblies for installation in your products. You get accurate and consistent performance because every order comes to you an exact duplicate of the original... consistently uniform in tolerances, temperature reaction and performance, thus preventing rejects and costly adjustments in assembly.

General Plate TRUFLEX thermostat metal assemblies are made to meet your specific requirements for temperature range, electrical resistance, corrosion resistance, etc. If you prefer to make your own elements, General Plate will produce TRUFLEX thermostat metal strip to your material specifications. Write for TRUFLEX thermostat metal catalog and engineering assistance.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
410 FOREST STREET, ATTLEBORO, MASSACHUSETTS

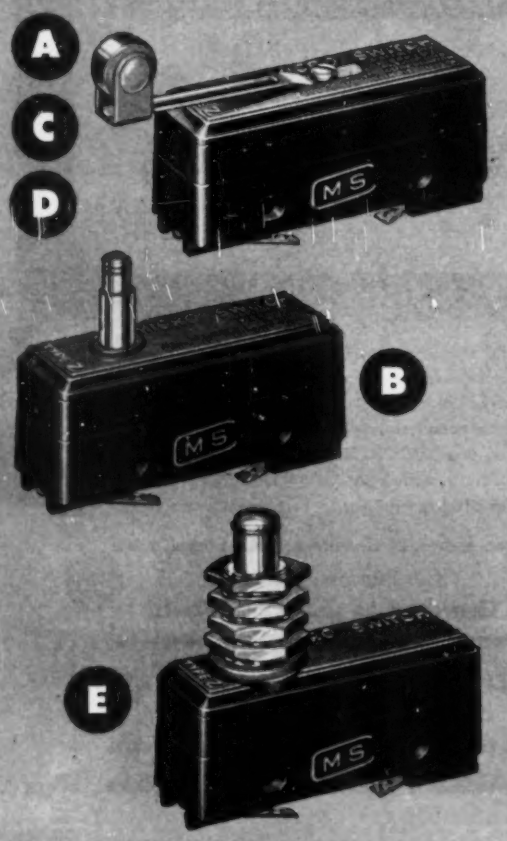
24 MICRO precision switches perform vital functions

These 3 MICRO switches of 8 different types function to make Robot the first fully automatic washer

● The three designs of MICRO switches shown include eight different types of operating characteristics and circuit arrangements required as controls for the Robot washer.

All have the MICRO characteristics of small size, light weight, accurate repeatability of operating point, high electrical rating and long-life dependability.

Letters indicate the location of these three MICRO switch designs in the open view of the Robot washer on the opposite page.



● This fully automatic commercial washer, which does the work of two or more manual washers, was developed by engineers of the Robot Laundry Machinery Sales, a division of the Wolf Company, Chambersburg, Pa.

Through the use of 24 MICRO precision switches, of eight different types, the designers were able to produce the first and only self-contained and completely automatic washer.

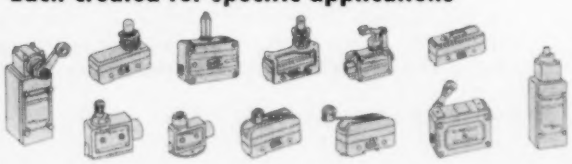
Under the automatic control of these MICRO switches, the Robot Washer—

1. Pre-mixes and releases supplies
2. Measures pre-determined gallonage of water
3. Controls water temperatures
4. Times each washing cycle
5. Injects steam at proper time
6. Dumps washer when cycle is completed

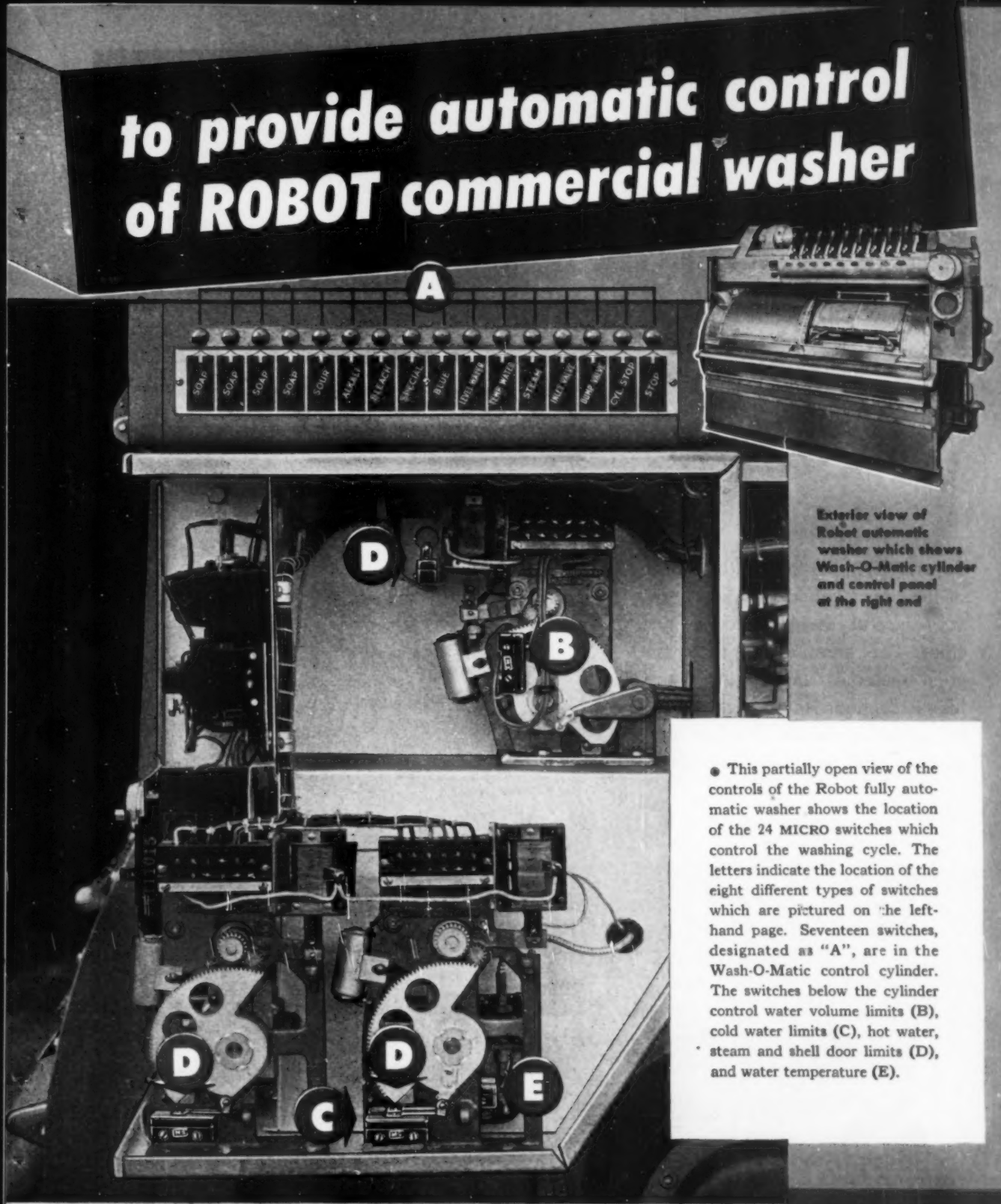
MICRO switches were chosen by Robot design engineers because of their long-life dependability and high electrical capacity . . . plus the ability of MICRO engineering to provide all the different types of switches which were required to control each operation most efficiently.

Whatever your design problem, you will find MICRO switches and MICRO field engineering counsel available to help you put not just *a* switch, but *the right switch in the right place*. These MICRO engineers, fully experienced in every type of switch application, have over 6000 variations of MICRO precision switches from which to help select the right switch for your design. We invite you to contact your nearest MICRO branch office.

OVER 6000 DIFFERENT SWITCHES . . .
Each created for specific applications



to provide automatic control of ROBOT commercial washer

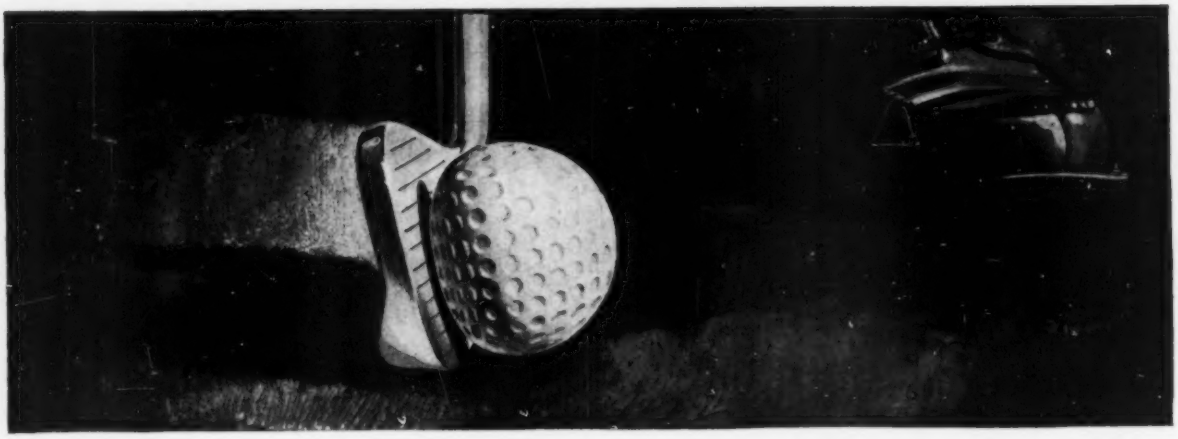


Exterior view of Robot automatic washer which shows Wash-O-Matic cylinder and control panel at the right end

● This partially open view of the controls of the Robot fully automatic washer shows the location of the 24 MICRO switches which control the washing cycle. The letters indicate the location of the eight different types of switches which are pictured on the left-hand page. Seventeen switches, designated as "A", are in the Wash-O-Matic control cylinder. The switches below the cylinder control water volume limits (B), cold water limits (C), hot water, steam and shell door limits (D), and water temperature (E).

MICRO
MAKERS OF PRECISION SWITCHES
FREEPORT, ILLINOIS

A DIVISION OF
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY



The expert's materials work with him!

Superior skill lies behind the shots of the expert golfer. But, he's also very careful in his selection of clubs. They must be shaped from good materials and balanced to his satisfaction. He takes care that the materials of his business are going to work *for* him and *with* him.

Add this Spec to Your Blueprints

Memorandum

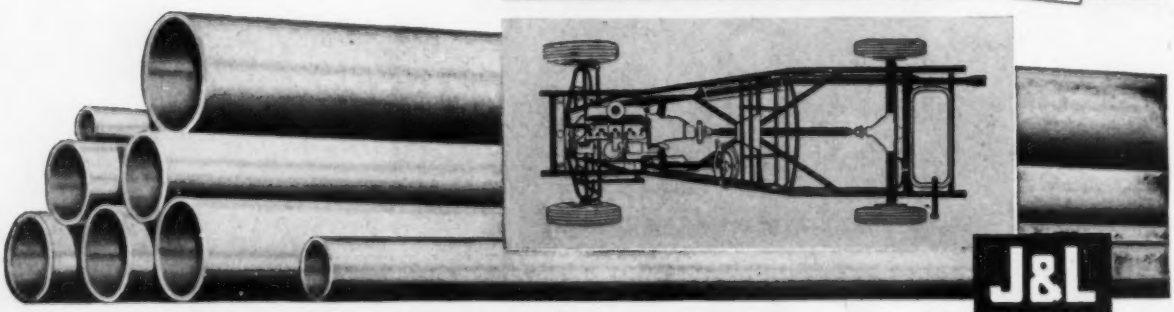
You can depend upon J&L ELECTRICWELD TUBING . . . it works *for* you and *with* you! It's made from J&L steel of carefully controlled quality.

You can depend upon J&L Electricweld Tubing for:

1. Uniform wall thickness (easy forming)
2. Strength (comparable in strength to heavier sections)
3. Ductility (easier, faster fabrication)
4. Reductions in weight (less weight in proportion to strength)
5. Smooth surface (ideal base for electro-plating, enameling, and painting)
6. Ready joining (by mechanical or welding methods)
7. Lower costs (savings in material and overall production costs)

**All standard lengths . . . diameters . . . wall thicknesses for the modern car*

WHEN YOU NEED TECHNICAL ASSISTANCE . . . call J&L. Our metallurgists can investigate your problem and suggest helpful applications of Electricweld Tubing.



JONES & LAUGHLIN STEEL CORPORATION
PITTSBURGH 30, PA.

J&L STEEL

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

You'll Remember the Quality of G.S. Small Gears

If their memories were as good as an elephant's, our oldest customers couldn't recall ever getting *troublesome* G.S. Gears. Why? Because *every one is made exactly right* . . to equal or exceed specifications. Continuous rigid inspection follows them every step of the way! As the world's largest designers and manufacturers of Small Gearing, *exclusively*, you can expect G.S. to deliver TOP quality, in production quantities, quickly, efficiently, economically. For your own best interests try this better Small Gear Service soon.

FRACTIONAL HORSEPOWER

GS

GEAR

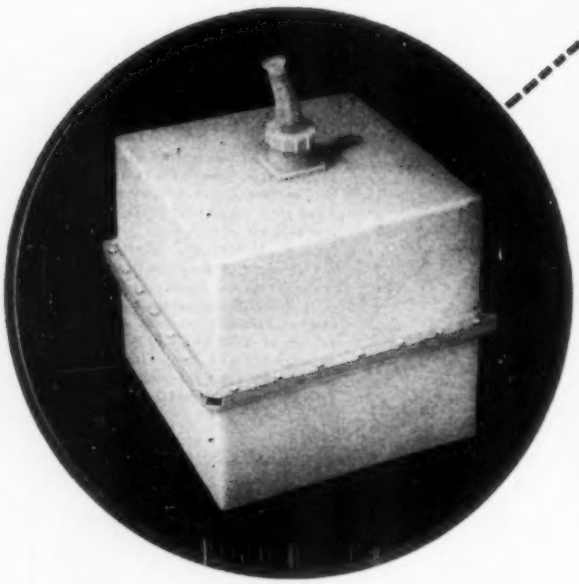
Specialties, Inc.

2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS
OF FRACTIONAL HORSEPOWER GEARING

New carboy container of Du Pont Alathon*



is light, tough, chemical-resistant

This new carboy offers improved utility and economy for the shipment and storage of corrosive chemicals. The 15-gallon inner container (complete with screw cap, seal and pouring spout) is molded of Du Pont "Alathon" polyethylene resin, yet weighs only 12 to 13 pounds. This saving in weight means easy handling, low shipping costs. The moldability of "Alathon" permits the square shape . . . means easy stacking and full use of shipping and storage space.

Du Pont "Alathon" has a low specific gravity (0.92) and exceptional resistance to chemical attack. "Alathon" is tough, resilient, virtually unbreakable—even at low temperatures. It contains no plasticizer . . . is non-contaminating. "Alathon" has a low rate of water-vapor transmission. And parts can be economically molded of "Alathon" by injection molding, cutting production time and costs.

Other examples of the product design and improvement possible with Du Pont "Alathon" are squeeze bottles, battery parts, pipe, flexible housewares, toys, TV lead-in wire and cable insulation ("Alathon" also has excellent dielectric properties). Perhaps this combination of properties can help you. For full information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 1010A Du Pont Bldg., Wilmington 98, Delaware.

*REG. U. S. PAT. OFF.

Containers molded by
A. L. Hyde Co., Grenloch, N. J.,
for Tennessee Products & Chemical Corp.,
Nashville, Tenn.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

NEW Telechron timer for your low-cost clock-radios

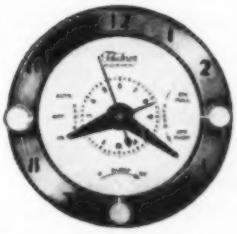
MODEL C-88 COMBINES QUALITY AND ECONOMY

Even in the lowest priced clock-radios in your line . . . now you can offer the extra sales advantages of a genuine Telechron timer. Because this new model C-88 brings the cost of a quality Telechron timer to an all-time low. And it brings you a new opportunity to boost sales in the low end of the price range, while maintaining the quality of your product. The C-88 features automatic switch-on with a single front knob. One-knob alarm and time set control is on back. Simplified dial uses pointer alarm hand. Available in square or round design.

A COMPLETE LINE OF BASIC TIMERS . . .

with wide choice of features, and adaptable to your own custom styling

C-91 . . . has automatic switch-on and signal alarm with TWO knobs



C-97 . . . has automatic switch-on, signal alarm and sleep switch with THREE knobs

C-98 performs same functions as C-97 (left) with TWO knobs

NEW BULLETIN GIVES COMPLETE DETAILS . . . *Send for your copy*

TELECHRON DEPT.
General Electric Co.
110 Homer Ave.
Ashland, Mass.

Yes, I want a copy of your new bulletin on Telechron radio timers.

NAME _____

FIRM _____

STREET _____

CITY _____ ZONE ____ STATE _____

Telechron
MARK OF TIMING LEADERSHIP

Photo Courtesy of The Maytag Company

Adding years to a washer's life

For the modern home the automatic washer is an automatic necessity. Why? Because young Mrs. America has discovered she can depend on her washer to help do her washing without failure, day in and day out.

Dependability like this doesn't just happen. It's planned! For instance, in the design of the Maytag automatic washer a rubber-coated balancing ring is called for to protect its inner tub from damage. To make sure this ring does its job properly and dependably, Maytag engineers specify the application of a tough 3M coating to protect the balancing ring not only from wear but also from the effects of hot water, steam and soap.

See what adhesives can do for you...

For the full story on 3M adhesives, coatings and sealers (and how they can help you!) call in your local 3M sales representative. Or write to us for a free booklet which describes many practical applications in detail. Address: 3M, Dept. 410, 417 Piquette Ave., Detroit 2, Michigan.

see our catalog in PRODUCT DESIGN FILE or write for copy

3M COMPANY

ADHESIVES•COATINGS•SEALERS

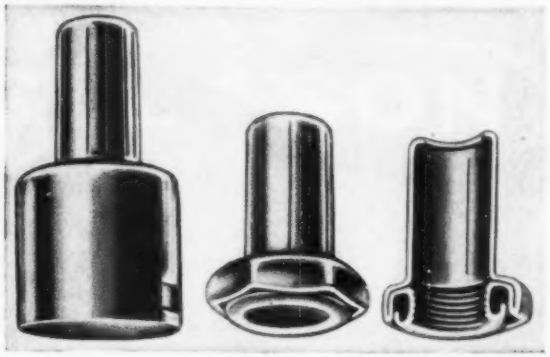
MINNESOTA MINING AND MANUFACTURING COMPANY
ADHESIVES AND COATINGS DIVISION • 417 PIQUETTE AVE., DETROIT 2, MICHIGAN
GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N.Y. 17, N.Y. • CANADA: LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Making this special nut from strip metal economically and in large quantities, called for highly skilled tool designing and a thorough knowledge of metalworking. All products on this page through the courtesy of The Risdon Manufacturing Company, Naugatuck, Conn.

Imagination Unlimited Lowers Cost of Strip Metal Components

Rising costs of labor and materials should not necessarily lead to increased prices of fabricated items. Imagination unlimited, the utilization of existing automatic machines, and clever tool designing are often the answer to offsetting increased costs.

Cost savings can sometimes be accomplished by making a one-piece item from a two-piece assembly, or by changing from a casting or a screw machine item to one made from strip metal, tubing or wire. Or savings may be obtained through the elimination of costly secondary operations or the reduction of scrap losses.

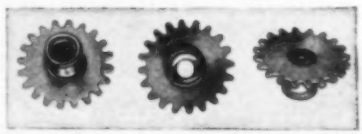
Automatic multi-station slide and eyelet machines have wonderful possibilities for cost saving for quantity items of limited size. A coil of strip metal is fed into one end of the machine and the finished items come out at the opposite end after it has undergone a large number of exacting operations. Speed, close tolerances, low scrap losses and economy are associated with these methods.

Strip Metal Nut Replaces Screw Machine Piece

The item illustrated above was originally made from hexagon rod and involved a number of operations such as machining, considerable drilling and threading. In redesigning this component from strip metal, 16 operations were involved, each of which had to be accurately planned so that a single annealing was required. After the draw, the metal was folded back against itself. It was then redrawn and folded back against itself after a clipping operation. Such a large amount of coldworking requires a thorough knowledge of the flow of metal in dies. Once perfected, the finished article is strong and considerably lighter.

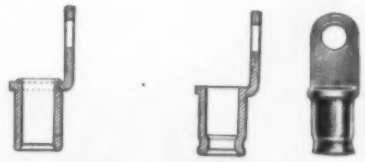
Making One-Piece Components

In small gears, concentricity between the pitch diameter of the gear teeth and the inside diameter of the bore is important. Originally the gear shown below was designed to be made in two pieces — a bushing and a gear blank assembled in a staking operation. When made in one piece from strip metal, this part was improved because it was uniform and concentric.



This improved, one-piece sheet-metal gear was originally made by staking two parts.

The following electric terminal was formerly a two-piece item made by assembling a screw machine bushing and a stamping. On making this complete in one piece from strip metal, savings were made in labor cost and material, although it involved an intricate set of dies and the use of an automatic multi-plunger machine.



Complete one-piece terminal made from strip brass in a single automatic multiple plunger machine.

Eliminating Drilling, Milling

This piece was formerly turned from tubing. A secondary operation was necessary for milling the slot. When converted to strip metal, it was made complete on an automatic press. The four slots were developed by piercing the metal in the blank and the finished piece was formed by redrawing.

Produced from Coiled Tubing

Formerly this terminal was made from tubing which was cut to length, formed, swaged, and pierced, each in a separate operation. In the new method all of these operations were combined. Coiled tubing was fed into an automatic multi-sliding machine that produced the complete part.

Bridgeport Technical Service

High-speed, automatic operations call for material made to exacting specifications and uniformity. Not only must the metal be free from imperfections but special physical properties are needed to withstand the severe coldworking operations which are performed without any intermediate annealing. Bridgeport Brass Company is well qualified to supply copper-base alloys to meet the exacting requirements of metal goods fabricators. All processes are under strict laboratory control. Please contact your nearest Bridgeport sales office and we will gladly help you with your metal problems and requirements. (439)

How to Fabricate More Profits

From 50% rejects to 1%
10c saved per piece
15% to 20% savings
40% rejects before—now 1%
8c to 10c saved per piece
From 20% rejects to none

This is a story of small change that put folding money in the pockets of a half-dozen fabricators of metal products.

The small change is that of specifying Carpenter Stainless Tubing rather than just "stainless tubing" . . . the folding money is attested by the captions under the pictures at the left.

What is more important to you, however, is the fact that none of the orders were for "specials" . . . all of these pieces were made from "mill run" tubing as delivered by Carpenter.

The moral of the story is, of course, that there *is* a difference in Stainless Tubing—and Carpenter makes it. Why not make the most of this *provable* difference in your own shop—for your own profit. Call your nearest Carpenter Distributor for your next order of tubing . . . plus design and engineering help if you need it. "One Call Does It All."

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.
Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE

Analysis — Tolerance — Finish

• guaranteed on every shipment

GLEASON announces . . .

5

new machines

No. 104 Straight Bevel CONIFLEX® Generator

No. 106 Hypoid Generator

No. 104 Angular Hypoid Tester

No. 104 Spur Tester

No. 104 CONIFLEX Cutter Sharpener

GLEASON

GLEASON WORKS · ROCHESTER 3, N.Y.

No. 104 Straight Bevel CONIFLEX Generator

for cutting straight bevel gears from 16 DP to 3 DP, 8½" diameter, 1⅛" face.

APPLICATION:

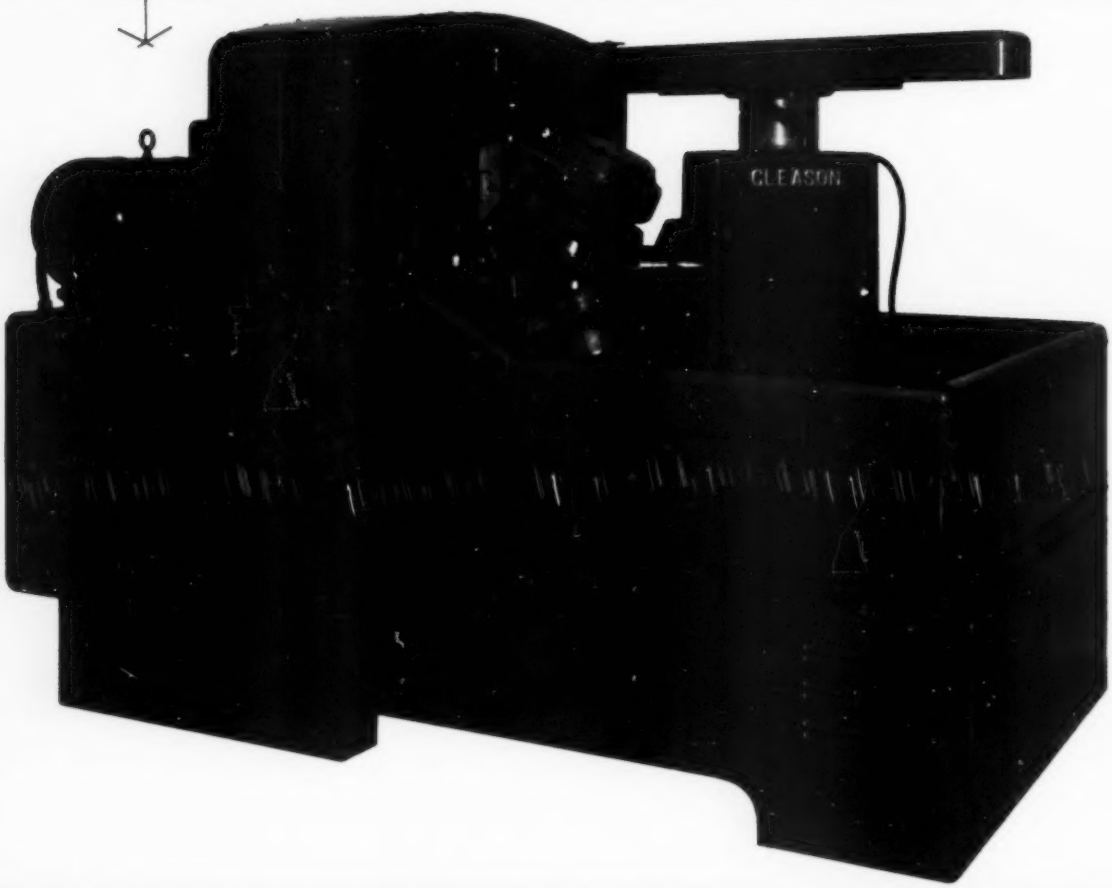
Completing of generated gears and pinions for volume production or small quantities.

ADVANTAGES:

Increased productivity—all gears completed from the solid blank in one operation . . . Highest quality — CONIFLEX tooth form fully interchangeable with that produced on Gleason two-tool generators.

FEATURES:

Cutting is done by two interlocking disc-type 9" diameter cutters . . . Small number of cutters covers entire machine range . . . Set-up and tooth development are simple . . . New generating method results in maximum cutter life, excellent finish, and high efficiency of the completing cycle.



GLEASON WORKS **ROCHESTER 3, N.Y.**

No. 106 Hypoid Generator

for cutting ZEROL® bevel, spiral bevel, and hypoid gears up to 4 DP, 8½" diameter, 1¼" face.

APPLICATION:

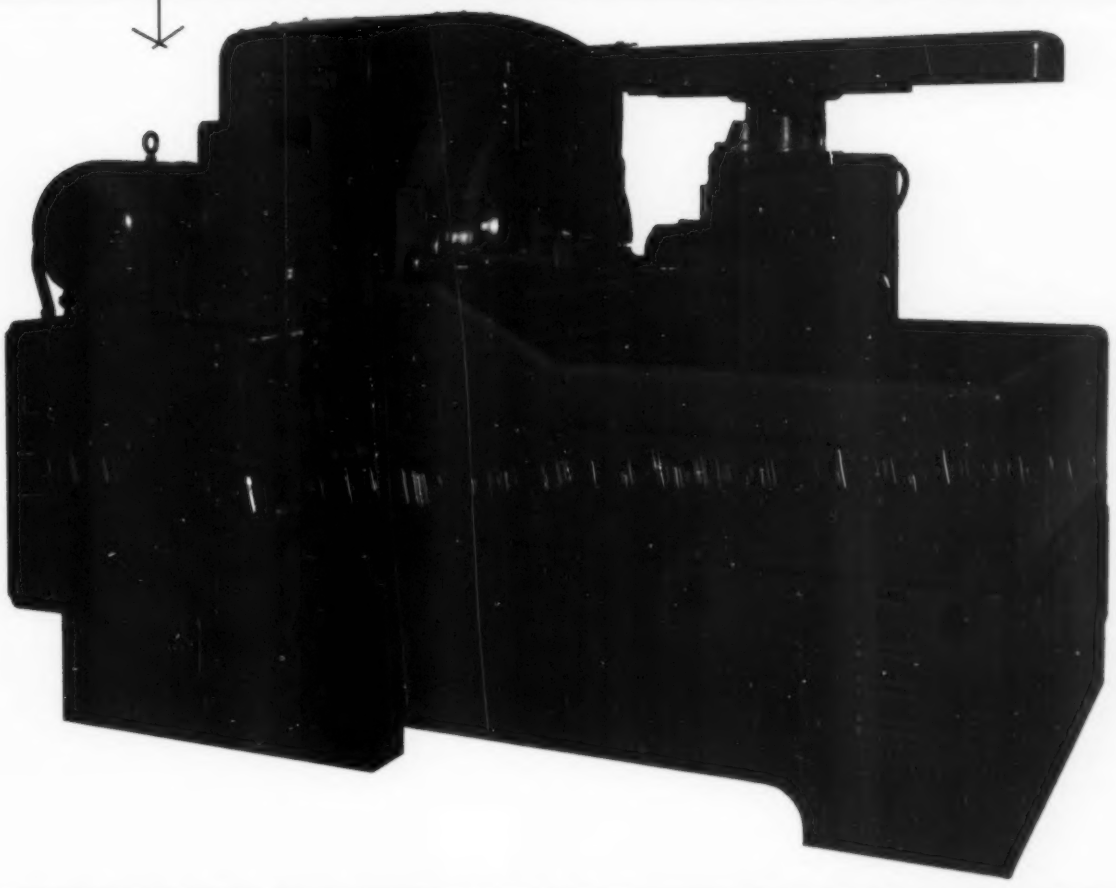
Completing, or separate roughing and finishing, of generated gears and pinions for volume production or small quantities.

ADVANTAGES:

Increased productivity—much faster rates are possible on finishing, and wider range of work can be completed in one operation . . . Improved quality . . . Set-up and tooth bearing development procedures are simplified.

FEATURES:

Use of cam-actuated generating motion increases cutting cycle efficiency . . . New type cutter spindle mounting gives greater rigidity, permits easier cutter truing on generator . . . Machine settings are simplified and permit use of all current spiral bevel, ZEROL bevel, and hypoid gear cutting systems.



GLEASON WORKS GLEASON **ROCHESTER 3, N.Y.**

No. 104
Angular Hypoid Tester

for bevel and hypoid gears up to 4¼" diameter.

APPLICATION:

Rolling test of composite tooth error, as well as power running test.

ADVANTAGES AND FEATURES:

More precise testing over a wide range of gear specifications . . . Three sizes of interchangeable spindles available for various gear sizes . . . Recording unit makes permanent chart of test results . . . Electric drag brake and wide range of speeds provided for running test.

No. 104
Spur Gear Tester

for spur and helical gears up to 4½" center distance.

APPLICATION:

Rolling test of composite tooth error, as well as power running test.

ADVANTAGES AND FEATURES:

One tester now provides both of above types of test for small spur and helical gears . . . Same features as No. 104 Angular Hypoid Tester—three spindle sizes, electronic recording unit, power testing facilities . . . Wide range of adjustments provided to accommodate various gear sizes and specifications.

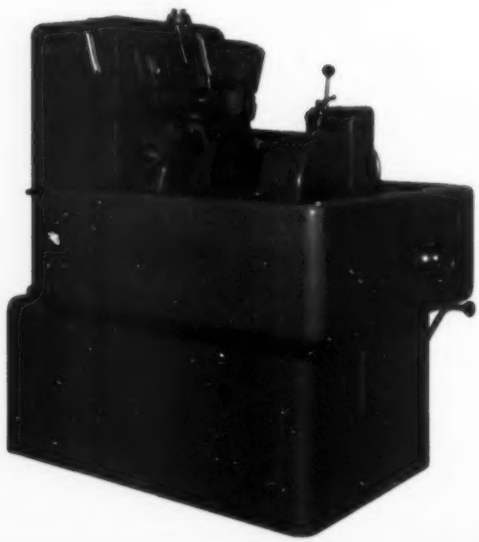
No. 104
CONIFLEX® Cutter Sharpener

APPLICATION:

Sharpening disc-type cutters used on No. 2A and No. 104 Straight Bevel CONIFLEX Generators.

ADVANTAGES AND FEATURES:

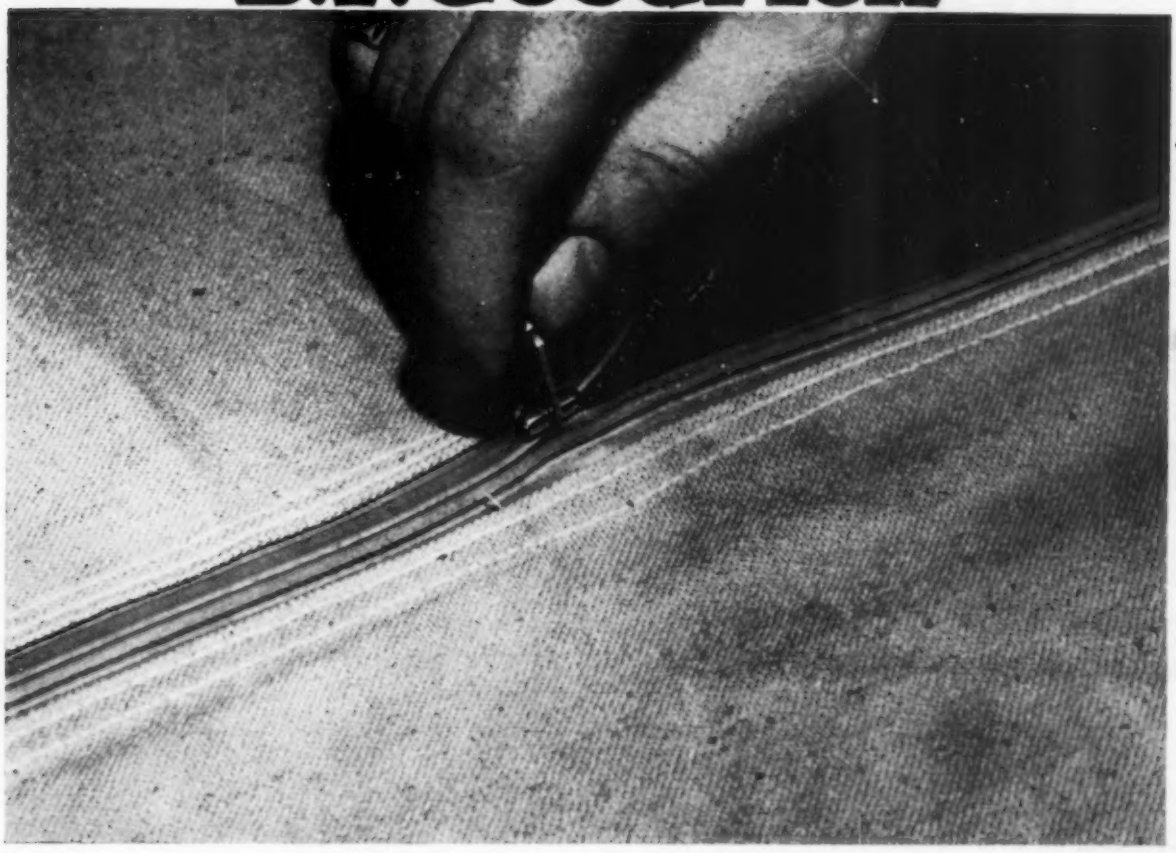
Wet grinding, with automatic stroke and feed control, assures longest cutter life . . . Exact sharpening angles are easily set and maintained . . . Machine set-up and changeover are simplified, for faster, more accurate, sharpening.



GLEASON

GLEASON WORKS · ROCHESTER 3, N.Y.

RESEARCH KEEPS **B.F.Goodrich** FIRST IN RUBBER



New kind of seal is watertight, airtight... zips open fast

A NEW KIND OF SEAL keeps gases, liquids, dirt *in* or *out*. Here's how it works:

Rubber lips are molded with hairline precision so that they fit together tightly. They press together even without pressure to seal effectively. And with pressure against the lips, the seal actually tightens. The rubber seal is applied to an ordinary zipper which zips open or shut in a hurry.

The B. F. Goodrich Sealing Zipper is so flexible it goes around curves and odd shapes where clamps won't work. Can be made of compounds to resist weather, oils, gasoline, chemicals. Can be sewn or cemented to fabric, metal, wood, glass. The rubber can be made to match any color. Production costs are often reduced because the zipper is so easy to install.

It has been used in life-saving suits, to seal delicate instruments against moisture, to seal lifeboats against sea water, to seal auto convertible tops against rain. It is ideal for any use that combines a need for an airtight, watertight seal with a need for quick opening.

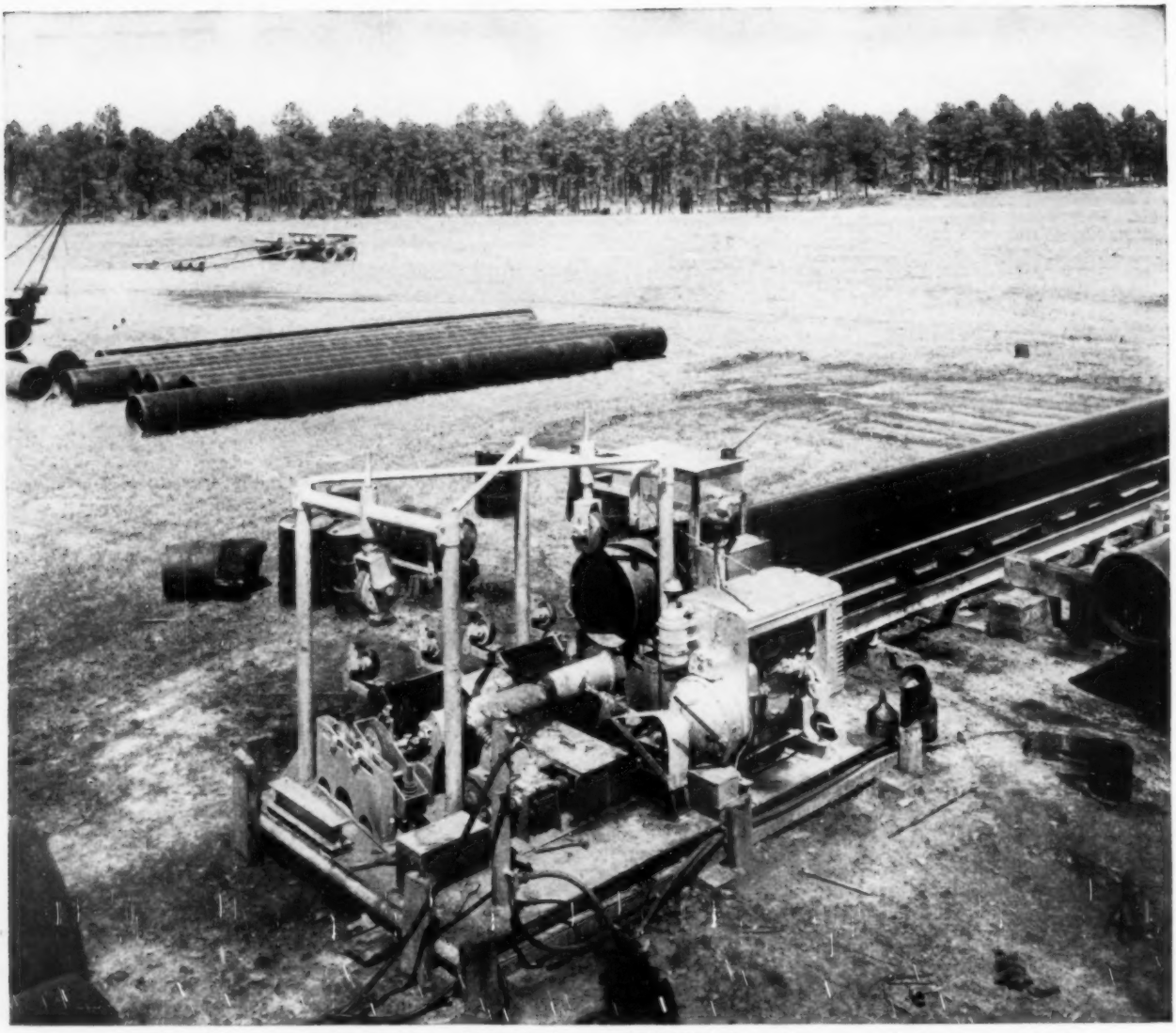
B.F.Goodrich **Airtight, Watertight Sealing Zipper**

Write for complete details, sending blueprints or specifications of your products to Dept. A-71 or send coupon below. The B. F. Goodrich Company, Zipper Division, Akron, Ohio.

Send Now for Free Folder
Gives case histories, design advantages, suggested uses.
The B. F. Goodrich Company
Dept. A-71, Akron 18, Ohio

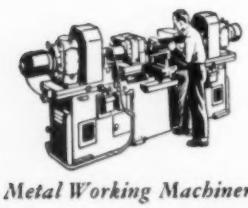
Name .....
Firm .....
Title .....
Address .....
City ..... *Zone* ... *State* .....

LINK-BELT ball and



In the oil fields—day-in, day-out, rain or shine—the bearings on this General Manufacturing Company's pipe cleaning and priming machine get a rough workout. That's why Link-Belt ball bearings are used throughout. Pounding vibration and continuous service, pipe rust and scale, sticky primer would quickly knock out any but the finest bearings.

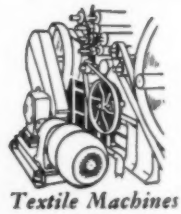
LINK-BELT ball and roller bearings



Metal Working Machinery

Farm Machinery

Construction Equipment



Textile Machines

roller bearings

...keep company with America's hardest-working machines

WHAT condition makes it tough for the bearings on your machines? Is it high speeds? Heavy loads? Excessive temperatures? Grit-laden atmosphere?

Whatever it is, you'll discover Link-Belt Ball and Roller Bearings assure long-life, free-rolling efficiency. On thousands of applications, these precision bearings have proved themselves —providing better machine performance . . . greater freedom from wear, excessive lubrication and maintenance.

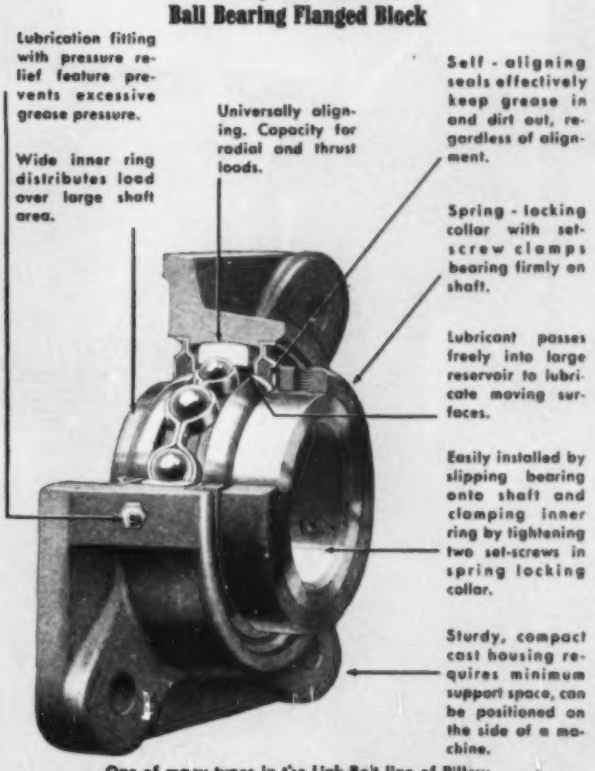
There's a Link-Belt Ball or Roller Bearing for every industrial need. Each meets the most exacting standards for quality. Each is a product of continuing research . . . sound engineering . . . highest grade materials . . . skilled craftsmanship . . . rigid inspection.

Let a Link-Belt bearing specialist give you expert advice on bearing selection. You can also get complete engineering information from Data Book 2550.

LINK-BELT

BALL AND ROLLER BEARINGS

Cutaway of Series 200 Ball Bearing Flanged Block

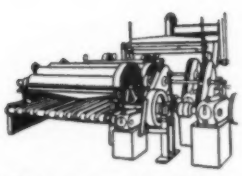

Lubrication fitting with pressure relief feature prevents excessive grease pressure.
Wide inner ring distributes load over large shaft area.
Universally aligning. Capacity for radial and thrust loads.
Self-aligning seals effectively keep grease in and dirt out, regardless of alignment.
Spring-locking collar with set-screw clamps bearing firmly on shaft.
Lubricant passes freely into large reservoir to lubricate moving surfaces.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set-screws in spring locking collar.
Sturdy, compact cast housing requires minimum support space, can be positioned on the side of a machine.

One of many types in the Link-Belt line of Pillow Blocks, Flanged, Flanged Cartridge, Cartridge, Hanger, Take-Up Blocks and Unmounted Bearings.

LINK-BELT COMPANY: Plants: Indianapolis, Chicago, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

13.1W

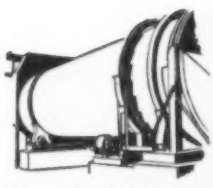
smooth the path of power for all industry



Pulp & Paper Machinery

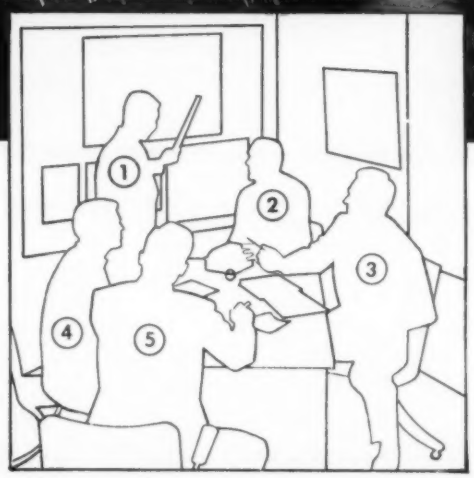
Materials Handling Equipment

Oil Field Equipment



Processing Equipment

1. Westinghouse Application Engineer
2. Westinghouse Sales Engineer
3. Chief Engineer
4. Electrical Engineer
5. Production Superintendent



Your motor and control problems are local . . . so is Westinghouse application assistance

Do you put a full team on the field when you tackle a motor and control application problem? Are you cashing in on the know-how of your local staff of Westinghouse application engineers? Take a look at this line-up:

Your local Westinghouse sales engineer has a broad knowledge of all Westinghouse Motors and Controls. He knows their capabilities and limitations. He knows how to match motors and controls for maximum production.

Your local Westinghouse application engineer is equipped to analyze any motor and control problem and then develop the best solution. He can handle any application problem from a simple machine tool to a complete production line.

Your local Westinghouse product engineer is a specialist in one type of motor or control. These men work at the local level but operate from a manufacturing headquarters office.

Enlist the services of these men on your next motor and control application job. Call your local Westinghouse office for further details, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21746

Application engineers work out of 126 Westinghouse offices

Akron 8, Ohio	JEfferson 3165	Fort Wayne 2, Ind.	ANthony 3421	Pittsburgh 30, Pa.	ATlantic 1-8400	Spokane 8, Wash.	MAin 3294
Albany 5, N. Y.	8-7801	Fort Worth 2, Tex.	FOrtune 4086	Portland 4, Ore.	CApitol 1-9151	Springfield, Ill.	3-1532
Albuquerque, N. M.	3-1826	Fresno 1, Cal.	4-5097	Providence 3, R. I.	GAspee 1-0818	Springfield 3, Mass.	6-8373
Allentown, Pa.	HEmlock 4-5108	Gary, Ind.	2-1468	Raleigh, N. C.	6302	Syracuse 4, N. Y.	2-1361
Amarillo, Texas	6-7838	Grand Rapids 2, Mich.	9-3106	Reading, Pa.	2-0287	Tacoma 2, Wash.	BRoadway 6565
Appleton, Wis.	4-4116	Greensboro, N. C.	2-3415	Richmond 19, Va.	2-4758	Tampa 1, Fla.	2-7246
Atlanta 2, Ga.	ATwood 1642	Greenville, S. C.	3-7755	Roanoke 4, Va.	6263	Toledo 4, Ohio	GArfield 4625
Augusta, Maine	3-4571	Hammond, Ind.	RUssell 8937	Rochester 7, N. Y.	MOnroe 1635	Trenton 10, N. J.	2-4136
Baltimore 2, Md.	PLaza 0300	Hartford 3, Conn.	5-0851	Rockford, Ill.	2-3452	Tulsa 3, Okla.	3-3191
Beaumont, Tex.	4-1481	Houston 2, Tex.	CHarter 4691	Rutland, Vt.	3292	Utica 1, N. Y.	4-1194
Binghamton 62, N. Y.	2-6403	Huntington 1, W. Va.	7146	Sacramento 14, Cal.	GIlbert 3-6525	Walla Walla, Wash.	5124
Birmingham 3, Ala.	53-2411	Indianapolis 9, Ind.	MArket 3301	Saginaw, Mich.	4-2640	Washington 6, D. C.	NAtional 8-8843
Bluefield, W. Va.	3-9131	Jackson, Mich.	2-0519	St. Louis 1, Mo.	CEntral 1120	Waterloo, Iowa	4679
Boston 10, Mass.	LIberty 2-0600	Jackson, Miss.	6-4839	Salt Lake City 1, Utah	5-3413	Watertown, N. Y.	1400
Bridgeport 8, Conn.	4-0151	Jacksonville 6, Fla.	78-6492	San Antonio 5, Tex.	GArfield 5114	Wheeling, W. Va.	6222-6223
Buffalo 3, N. Y.	WAshington 3966	Jamestown, N. Y.	8939	San Diego 1, Cal.	MAin 8151	Wichita 2, Kansas	5-2631
Butte, Mont.	2-2301	Johnstown, Pa.	81-257	San Francisco 8, Cal.	EXbrook 2-5353	Wilkes-Barre, Pa.	3-1144
Canton 2, Ohio	3-9171	Kansas City 6, Mo.	HArrison 7122	Seattle 4, Wash.	MAin 0808	Williamsport, Pa.	4289
Cedar Rapids, Ia.	7638	Kingsport, Tenn.	3769	Shreveport, La.	4-5298	Worcester 8, Mass.	4-2648
Charleston, S. C.	9904	Knoxville 8, Tenn.	2-8101	Sioux City 4, Iowa	5-7634	York, Pa.	7851
Charleston 1, W. Va.	37-565	Little Rock, Ark.	4-0367	South Bend 4, Ind.	3-7167	Youngstown 3, Ohio	4-1118
Charlotte 1, N. C.	5-3731	Los Angeles 17, Cal.	MAdison 6-3881				
Chattanooga 2, Tenn.	7-4361	Louisville 2, Ky.	CLay 0212				
Chicago 54, Ill.	WHitehall 4-3860	Madison 3, Wis.	5-4868				
Cincinnati 2, Ohio	GArfield 2250	Medford, Ore.	2-8289				
Cleveland 13, Ohio	CHerry 1-7600	Memphis 3, Tenn.	8-8546				
Columbia, S. C.	3-8823	Miami 4, Fla.	2-1553				
Columbus 15, Ohio	MAin 5527	Milwaukee 2, Wis.	DAly 8-1800				
Corpus Christi, Tex.	3-9237	Minneapolis 13, Minn.	GRanville 3545				
Dallas 1, Tex.	RIverside 5231	Mobile, Ala.	8-5443				
Davenport, Ia.	3-2761	Nashville 3, Tenn.	42-3505				
Dayton 2, Ohio	ADams 9153	Newark 2, N. J.	MArket 2-0200				
Denver 2, Colo.	KEystone 8121	New Haven 10, Conn.	5-3191				
Des Moines 8, Iowa	2-0244	New Orleans 13, La.	RAymond 8656				
Detroit 31, Mich.	TRinity 2-7010	New York 5, N. Y.	WHitehall 3-4321				
Duluth 2, Minn.	7-1541	Niagara Falls, N. Y.	9700				
El Paso, Tex.	2-5691	Norfolk 10, Va.	5-1639				
Emeryville 8, Cal.	OLympic 2-3770	Oklahoma City 2, Okla.	REgent 6-1633				
Erie, Pa.	24-867	Omaha 2, Nebr.	HArney 8700				
Evansville 8, Ind.	5-7146	Peoria 3, Ill.	2-5439				
Fairmont, W. Va.	501	Philadelphia 4, Pa.	EVergreen 2-1200				
Fergus Falls, Minn.	4250	Phoenix, Ariz.	4-3158				

YOU CAN BE SURE...IF IT'S Westinghouse

HEIM *spherical bearing* rod ends fly "NO HANDS"

When the Radioplane Co. of Van Nuys, Cal., designed their Pilotless Aircraft Target Plane, they chose Heim Rod Ends for all the myriad linkage mechanisms.

This standardized Air Force and Army Field Forces Aerial Target is remotely controlled by radio, and after completion of its mission is recovered by use of a 36 ft. parachute. In the event of a direct hit by gunfire or loss of radio control, the parachute is deployed automatically. The target is of aluminum alloy construction and easily repaired and prepared for flight if damaged by gunfire.

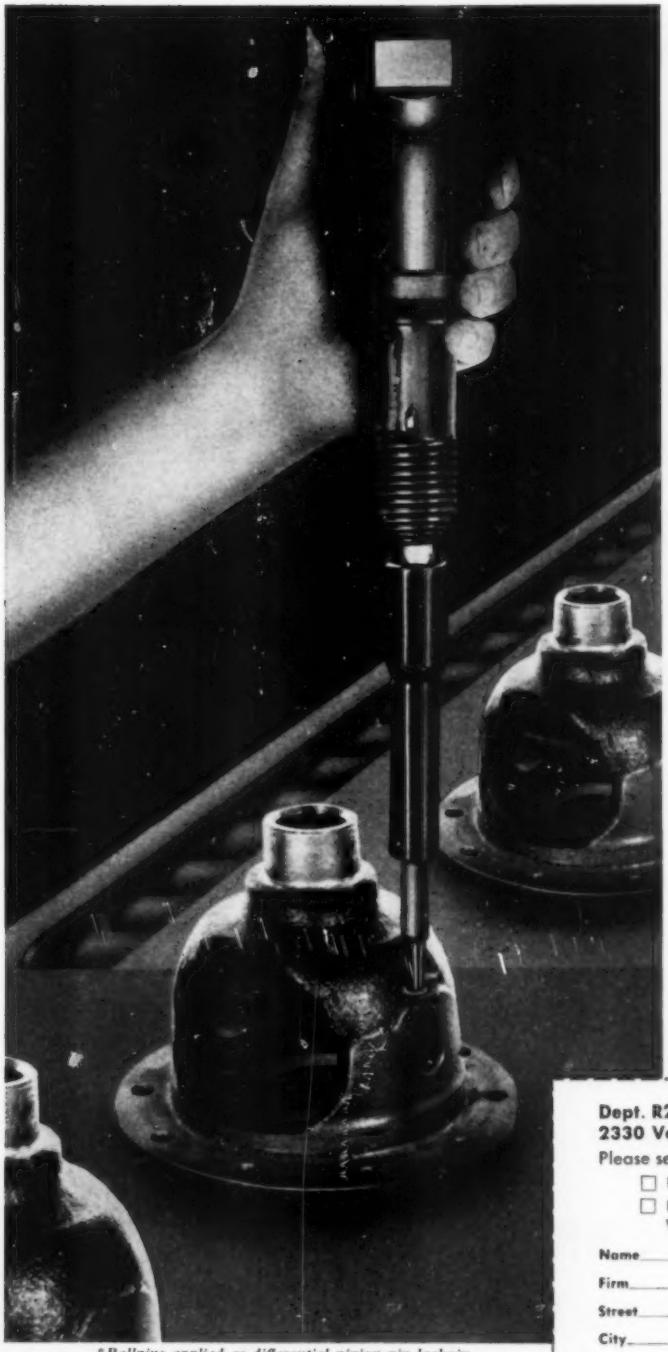
There is a Heim Spherical Bearing or a Heim Rod End for you, too. The Heim Unibal is a single ball oscillating in a bronze socket. It will save you time and money and will deliver superior performance. And it will compensate for shaft misalignment in all directions.

Would you like a sample bearing?
We have set aside a few for this purpose. Please write.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Ford Cuts Assembly Costs using

ROLLPIN TRADE MARK



*Rollpins applied as differential pinion pin lockpin on the Ford Motor Mound Road Plant assembly line.

Rollpin is the slotted tubular steel spring pin with chamfered ends. Simply drive it into holes drilled to normal production tolerances. It compresses as driven—and its spring action locks it in place regardless of impact loading, stress reversals or vibration.

Rollpin assembly eliminates extra operations and parts. There is no precision drilling, threading, peening—and no cotter pins or other locking devices. Cost savings as great as 90% result—depending upon the type of fastener replaced and the assembly method now in use. Our illustration is an air gun set-up that installs Rollpin at the rate of 8 units a minute on the Ford assembly line.*

Other insertion procedures range from simply driving Rollpin with a hammer to more intricate hopper-fed methods. Independent time studies have shown installed costs of Rollpin at 9% of that for a dowel pin and *less than* 5% of the installed cost of a taper pin.

Mail our coupon for information on how Rollpin will do your fastening faster and cheaper.

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R23-102 Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send the following free fastening information:

☐ Rollpin bulletin ☐ ELASTIC STOP® nut bulletin

☐ Here is a drawing of our product. What ESNA® fastener would you suggest?

Name_____ Title_____

Firm_____

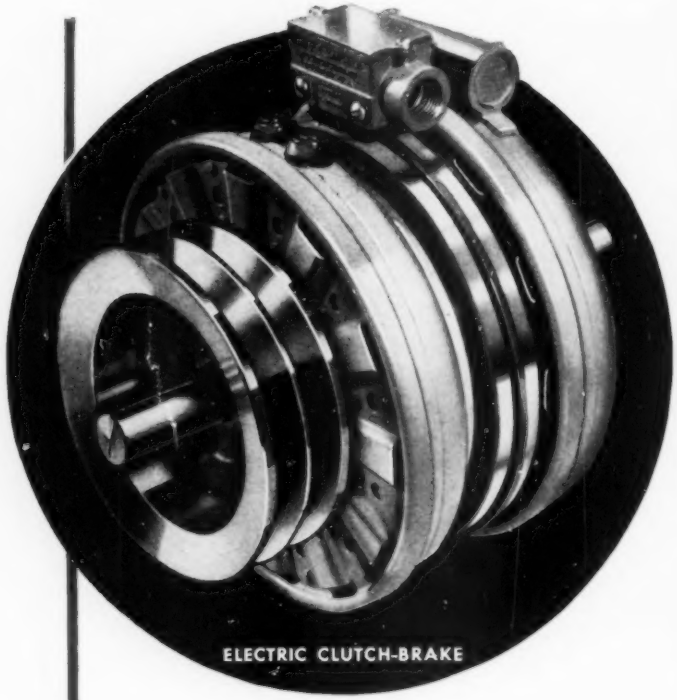
Street_____

City_____ Zone____ State_____

Accurate positioning improves quality when Warner Electric Brakes and Clutches take control for Coulter & McKenzie

WARNER
electric motion control

- speeds cycling for faster output
- makes possible tolerances never before obtained in coil industry
- provides greater accuracy at lower production cost
- reduces setup time
- eases burden on manpower, makes operation safer



ELECTRIC CLUTCH-BRAKE

Picture this automatic giant picking up a bar from accurate rest position as it emerges from the furnace, watch it insert the metal through guides to gripper, controlling every step of production until a coil spring is made—and you'll recognize Warner's contribution to the new Coulter & McKenzie spring coiling machine. Manned expertly and safely by Warner Electric Brakes and Clutches, this machine makes a complete cycle, coiling spring, stripping and returning to absolute starting position—automatically.

So advanced are the control features engineered into the new model that a 3-day preview and working demonstration was recently held at the Bridgeport plant for representatives of leading companies—among them Crucible Steel, Ford Motor, and Canadian Car and Foundry.

Coulter & McKenzie predicts this Warner-equipped machine will enable railroad, heavy equipment and automotive designers to engineer their products better, get greater accuracy and higher rate of production because of the instantaneous, positive positioning and automatic electric control of all component parts.

Results in management terms? Production increase, elimination of operator inefficiency, consistent accuracy —every one a potential profit maker.

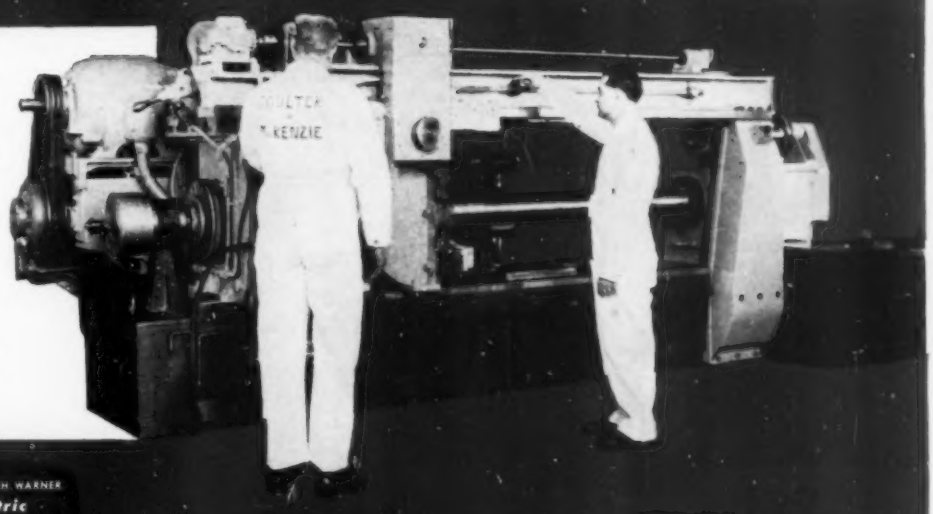
Warner Electric Brakes and Clutches to start and stop your machines may mean profits you aren't getting now. Call your Warner representative to solve your control problem profitably.

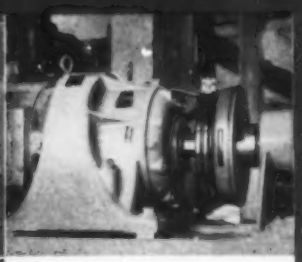
WARNER

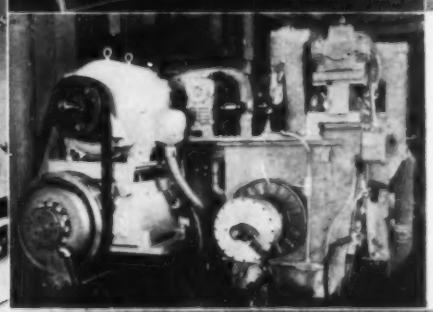
ELECTRIC BRAKES & CLUTCHES

FOR INDUSTRIAL APPLICATIONS

Almost every railroad and passenger car built since steam and gasoline engines has been equipped with springs made on Coulter & McKenzie machines. Two Warner Electric Brakes and five Clutches control movements of Model 88, 16" x 60" Automatic Spring Coiler, illustrated, which works electrically with only one operator.







Extraction drive, upper left, with Warner Model 1000 Electric Clutch-Coupling, Model 1225 Brake. Brake returns mandrel to accurate, positive stop ready to wind next spring. Far left, coiler is positioned at electric control console away from furnace heat.

Mandrel rotating drive, above, has Warner Model 1000 Clutch-Coupling to quickly and positively couple motor to roller chain drive.

Main drive, left, is powered by 50 hp, 1800 rpm motor. 4-speed transmission has Warner Electric Clutch, with armature mounted inside drive pulley on input shaft. Warner Electric Brake stops spindle instantly, in exact position for winding.

Warner Electric Brakes, Clutches and Clutch-Brakes give you new, unique simplicity of design and operation. There are only two main parts, an armature and magnet. Operation is by *electro-magnetic*, instantaneous engagement and release of friction surfaces. Torque ratings are extremely high for small size and light weight. No coasting or slipping when "locked in." Easily designed into original equipment. Readily adapted to automatic cycles and remote control by limit switches, relays, electric eyes, pushbuttons, etc. Rate of application accurately controlled to synchronize motions—give exact degree of speed and power required.

COMPLETE ENGINEERING SERVICE . . . Warner offers complete application and design engineering service and field assistance. If you have a clutching, braking, tensioning, indexing, or speed control problem, consult competent, experienced Warner brake and clutch specialists for reliable recommendations on torque, heat, electrical controls, capacity, etc.

WRITE For NEW CLUTCH CATALOG—

20-page booklet packed with specifications, data, features, and design data pertaining to Warner Clutches and Clutch-Couplers.

Warner Electric Brake & Clutch Co., Dept. PE, Beloit, Wis.

☐ Please send your FREE Booklet, WEB 6089.

☐ Would like to see working demonstration.

Firm Name_____

Individual_____ Title_____

Address_____

City_____ State_____

is CORROSION RESISTANCE

. . . your problem?

Long experience in the development of precision instruments enables Ketay to manufacture Synchros, Servos and Resolvers to meet the cycling humidity requirements of MIL-E-5272

As a leader in the use of *corrosion resistant* materials in Synchros, Servos, Resolvers, Control Equipment and related instruments, Ketay has enormously broadened their usefulness for both the government and industry.

Ketay has built an outstanding record as originators of units to meet individual specifications. Ketay engineers will be glad to discuss your requirements.

CORROSION RESISTANT UNITS

Ketay offers a complete line of Corrosion Resistant Instruments, four of which are pictured above. From left to right they are:

- Synchro, Size 23, Frame O.D. 2.250", 26 V and 115 V 400 & 60 Cycles. (Transmitter, Receiver, Resolver, Differential, Control Transformer) Also available in same frame size: Servo Motor—115 V 60 Cycles.
- Synchro, Size 15, Frame O.D. 1.437", 26 V and 115 V 400 Cycles. (Transmitter, Receiver, Resolver, Differential, Control Transformer) Also available in same frame size: Servo Motor Mk 7—115 V 400 Cycles.
- Synchro, Size 11, Frame O.D. 1.062", 26 V and 115 V 400 Cycles. (Transmitter, Receiver, Resolver, Differential, Control Transformer) Also available in same frame size: Servo Motor Mk 14—115 V 400 Cycles.
- Synchro, Size 10, Frame O.D. .937", 26 V 400 Cycles. (Transmitter, Receiver, Resolver, Differential, Control Transformer) Also available in same frame size: Servo Motor—26 V 400 Cycles.

Send for illustrated Catalog today!

Ketay

MANUFACTURING CORPORATION

Executive Offices
555 Broadway
New York 12, N. Y.

●

West Coast Sales
12833 Simms Avenue
Hawthorne, California

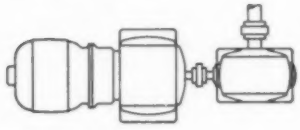
DESIGN
DEVELOPMENT
MANUFACTURE
. . . of precision instruments components, systems.

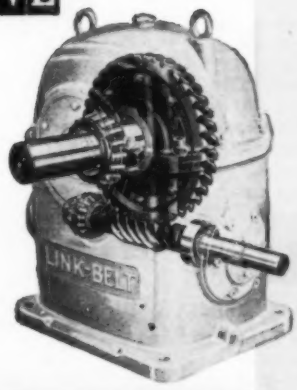
Kinetix Instrument Division • Marine Division • Pacific Division • New York Division • Research & Development Division

How to change even complex speed reduction problems into *simple* ones

WORM GEAR DRIVE

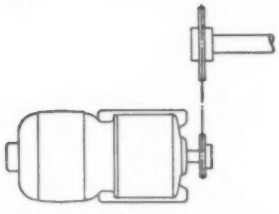
WORM GEAR and P.I.V. variable speed drives are shown direct-coupled. Link-Belt worm gear drives are available in 3.1:1 to 8000:1 reduction ratios—1400 to 123,000 in. lbs. torque—0.22 to 564 output shaft rpm. Ask for Book 2324A.





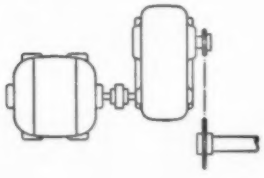
GEARMOTOR & HELICAL GEAR DRIVE

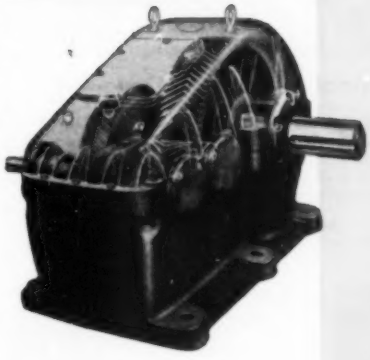
GEARMOTOR is shown with roller chain drive. Link-Belt Helical Gear Drives, Gearmotors and Motogears are available in 6.2:1 to 292:1 reduction ratios—1 to 30 hp—6 to 280 output shaft rpm. Ask for Books 2247 and 2451.



HERRINGBONE GEAR DRIVE

HERRINGBONE GEAR DRIVE is shown connected by flexible coupling to motor and with roller chain take-off. Link-Belt Herringbone Gear Drives are available in 2.84:1 to 326:1 ratios—0.4 to 2480 hp—2.2 to 623 output shaft rpm. Ask for Book 2519.





Get the proper drive combination that best meets your requirements from the broad LINK-BELT line

In addition to matching a wide range of requirements for ratio, hp, loading conditions and similar factors—Link-Belt enclosed gear drives offer you other benefits. When your Link-Belt representative selects a helical, herringbone or worm gear drive, you have no worries about coordinating it with your other components.

For Link-Belt builds a complete power transmission line. There's no need to exchange drawings with a third person to calculate chain, sprocket, coupling, bearing or even shafting requirements. You can get all these from one source . . . each pre-engineered for perfect fit.

Next time you're faced with a speed reduction problem, take it to power transmission headquarters. There's a Link-Belt sales office near you. Call today for complete engineering information.

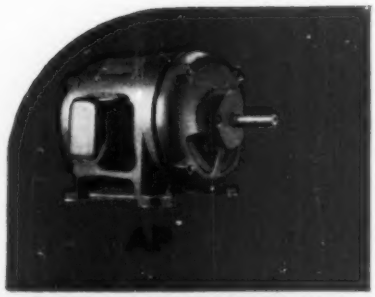
LINK-BELT

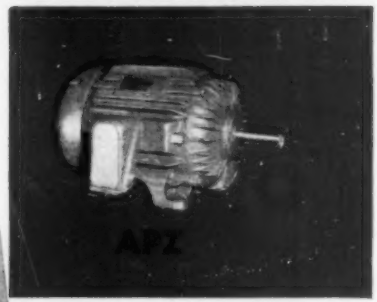
ENCLOSED GEAR DRIVES

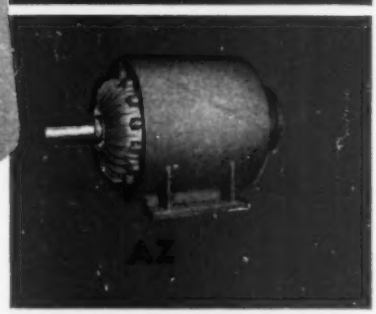
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

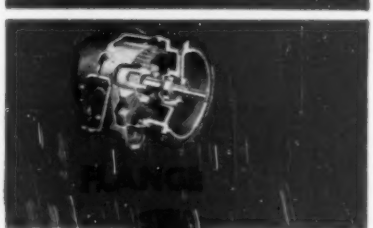
13,128-A

Find the Answer to Your Motor Problems Here ⇨









ALLIS-CHALMERS Motors for Designers

ON THIS CHART YOU WILL FIND a standard type Allis-Chalmers motor to fit nearly every design need from ½ hp up. Many of them have exclusive construction features, such as fin cooling and tube cooling, which offer you premium performance without premium price. Many times these features will enable you to improve your design without adding to the cost of the machine.

And, of course, modifications from strictly standard designs can easily be made to fit your particular requirements.

FREE HELP FROM EXPERIENCED DESIGN ENGINEERS

If you have a special problem, Allis-Chalmers will gladly furnish experienced design engineers to help you work out your motor problems. Allis-Chalmers design engineers are particularly helpful because A-C's strong background in control, drives and many types of driven machines gives them an especially intimate knowledge of motor requirements.

When you have a design problem involving motors — or any part of the machine from power line to driven shaft — call your nearby Allis-Chalmers District Office. In the meantime, send the coupon below for a complete booklet of motor types and characteristics. Ask for Bulletin 51B6052M.

SEND COUPON FOR FREE LITERATURE AND SELECTION CHARTS

Allis-Chalmers Manufacturing Company
Box 512, Milwaukee 1, Wisconsin

Please send me the following free literature to help me solve my design problems.

- ☐ Handy Guide to Electric Motors (51B6052)
- ☐ Handy Guide to *Texrope* Drives (20B6051)
- ☐ Across the Line Starters (14B7132)

Name .....

Company .....

Position .....

Address .....

City ..... State .....

A-3575

One Source for Complete Drive Unit

Control Motor *Texrope* Drive

Engineered and built to work together. Your Allis-Chalmers District Office Representative can supply you with a complete, coordinated drive. You save selection time and are sure of dependable operation.

Texrope is an Allis-Chalmers trademark.

ALLIS-

RANGE

½ to 150 hp. 450 to 3600 rpm. 208, 220, 440, 550 volts. Frames 204 to 445 in AP construction. 504 and 505 in AW construction.

CONSTRUCTION

Stator yokes for AP motors are cast iron and have no bottom openings. AW motors are built with cast steel yoke heads, with integral mounting feet, and heavy continuous-welded steel drip covers. Stator slots are semi-closed for the smaller sizes, open type with form-wound coils for the larger sizes. Windings are multiple dipped and baked. Rotors are cast aluminum with integral fans in frames 405 and smaller. Copper or copper alloy is used for larger ratings. Bearing end shields are cast iron. Ball bearings are available in all sizes. Sleeve bearings in some larger sizes.

MODIFICATIONS

Basic motor is open drip-proof rated 40°C continuous, NEMA Design B. Design C and D motors also are standard while Design A motors are considered special. Other electrical modifications available include 110 volts on frames 326 and smaller and 2300 volts on frames 445 and larger, and multi-speed motors with constant torque, variable torque and constant horsepower. Mechanical modifications include splash-proof rated 50°C continuous. Other modifications, both mechanical and electrical, can be made to suit your specific requirements.

RANGE

½ to 100 hp. 600 to 3600 rpm. 208, 220, 440, 550 volts. Frames 203 to 254 in non-ventilated construction. Frames 254 to 505 TEFC construction.

CONSTRUCTION

Special non-clogging design blows itself clean, is easy to wipe or blow off if oily or moist dirt sticks.

Fan-cooled and non-ventilated types have the same construction except that the fan-cooled motors have an external fan and fan shield to circulate and direct air over the motor enclosure. Stator yoke is ribbed cast iron, designed for easy cleaning. Stator winding is the same as in open types. Bearing end shields are ribbed cast iron. Ball bearings are used except for 75 and 100 hp, 3600 rpm motors, which have split sleeve bearing construction.

Explosion-proof motors have extra deep rabbeted housing fits and bearing seals. All seals are metal to metal.

MODIFICATIONS

Basic motor is totally-enclosed, fan-cooled rated 55°C continuous, NEMA Design B. Design C and D motors also are standard while Design A motors are special. Same electrical modifications are available as in open types. Mechanical modifications include non-ventilated in smaller sizes and explosion-proof, both ventilated and non-ventilated, approved by Underwriters for Class I, Group D and Class II, Group F and G hazards.

RANGE

40 to 2500 hp. 600 to 3600 rpm. 208, 220, 440, 550 volts plus higher voltage in larger sizes.

CONSTRUCTION

Ventilating system is simple but highly efficient. The stator core is surrounded by a nest of tubes. Internal fans circulate the inside air around the tubes, while an external fan drives outside air through tubes to dissipate the heat. This arrangement permits full internal air circulation. Cleaning is easy but seldom necessary. Stator yoke is heavy fabricated steel construction. Cooling tubes are generally copper but may be of other materials. Rotor construction is determined by speed, rating, and application. Bearing end shields are heavy cast iron, with internal and external ribs. Ball bearings are used except 3600 rpm, which have sleeve bearings. Explosion-proof motors differ from standard enclosed machines only in details.

MODIFICATIONS

Basic motor is totally-enclosed, fan-cooled rated 55°C continuous, NEMA Design B. Design D and C motors also are standard while Design A motors are considered special. Same electrical modifications are available as in open types. Mechanical modifications include explosion-proof construction in all sizes approved by Underwriters for Class I, Group D and Class II, Group F and G hazards. Cooling tubes may be made of any material to withstand corrosive action of refinery vapors, fly ash, and other air-borne corrosives. This motor also available in vertical mounting type in all sizes.

RANGE

7.5 to 520 rpm with 1750 rpm motors. 1 to 50 hp. 208, 220, 440, 550 volts. Horizontal or vertical types.

CONSTRUCTION

Integral type uses round frame, D-flange motor, resulting in shorter overall length. All-motor type uses standard foot-mounted motor—recommended whenever space permits. AGMA Class I, II, III gears for steady loads, moderate shock loads, and heavy shock loads respectively. Gears have compact, rigid, all steel housings. Large shafts, husky bearings and strong bearing mountings resist severe loading. Heat treated alloy steel helical gears are lubricated by direct dip for safe continuous lubrication, protected by heavy duty shaft seals.

MODIFICATIONS

Any standard motor may be used with the complete range of mechanical and electrical modifications shown above. In addition, special designs can be built to meet special problems.

RANGE

½ to 150 hp. 450 to 3600 rpm. 208, 220, 440, 550 volts. Frames 203 to 505 in all constructions.

CONSTRUCTION

NEMA C face and D flange mounting construction is available in frames 505 and smaller in the same range of rating as the AP and AW types of motors shown at left, including mechanical modifications such as splash-proof and enclosed construction. Construction features and electrical modifications available are also the same as for the standard motors.

MODIFICATIONS

Flange motors may be supplied with or without feet, as required. Round frame motors without feet include a special ventilating fan to supplement the regular rotor fans. The mounting face or flange may be obtained especially machined to fit specific applications at moderate additional cost. Motors may be mounted horizontally, vertically (except in certain cases) or at an angle.

RANGE

½ hp and up. 450 to 3600 rpm. 208, 220, 440, 550, 2300 and higher voltages. Frames 203 to 505 and up.

CONSTRUCTION

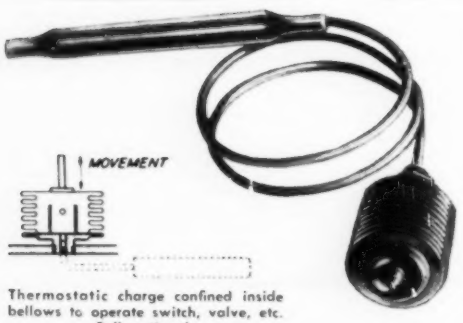
Vertical motors with NEMA type P bases are available in the same range of ratings as the AP, AW, and AZ types shown at left, including mechanical modifications such as totally-enclosed and explosion-proof construction. Construction features and electrical modifications are same as for standard horizontal motors.

MODIFICATIONS

Ball bearings are interchangeable with those of horizontal motors. Special bearings for additional thrust carrying capacity are available in some cases. Where required special lubricating and grease retaining features are available.

CHALMERS

THE SPECIALIST ALWAYS KNOWS BEST!



Thermostatic charge confined inside bellows to operate switch, valve, etc. Bulb optional.

● If you use or need bellows assemblies, check with the specialists at Fulton Sylphon or Bridgeport Thermostat. Our more than half-a-century of experience in this specialized field can be a big help to you.

For one thing, we can take care of your bellows assemblies requirements quickly and accurately—help you save time, production problems and expense.

Or, if you require a specific type of assembly, our specialists will work with you to design and produce exactly what you need.

Sylphon and Bridgeport bellows assemblies are used to help solve many design problems involving control of temperature or pressure. Typical examples of their use are: as flexible connectors, for thermostatic devices, hydraulic mechanisms, expansion joints, pressure controls. Wide range of metals and sizes.

Write for helpful advice on your bellows assemblies needs or problems. And for ideas, ask for Catalog TP-1400

FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

Robertshaw-Fulton CONTROLS COMPANY
EVERYTHING UNDER CONTROL

BRIDGEPORT THERMOSTAT DIVISION
Bridgeport 1, Conn.

TEMPERATURE CONTROLS • BELLOWS ASSEMBLIES • BELLOWS DEVICES

Check these advantages of ALSIMAG

TRANSFORMER AND HIGH VOLTAGE CAPACITOR TERMINALS

- ☐ High surface resistivity
- ☐ High dielectric strength
- ☐ High mechanical strength
- ☐ High volume resistivity
- ☐ Low loss factor
- ☐ Low Porosity
- ☐ Dimensionally accurate
- ☐ Uniform
- ☐ Totally and permanently rigid
- ☐ Suitable as compression type or metallized for soft solder sealing
- ☐ Economically produced to your specifications in large or small quantities

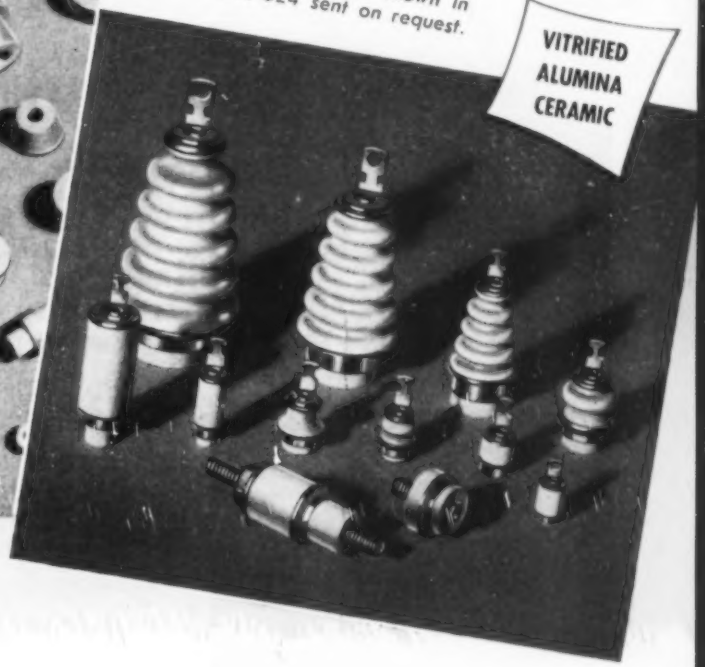
Send blue print or samples and let us show you what we can do for you.

METALLIZED HERMETIC TERMINALS

For sealing transformers and other electrical components

-Custom made for your requirements. Many standard designs shown in Bulletin No. 524 sent on request.

VITRIFIED ALUMINA CERAMIC



52ND YEAR OF CERAMIC LEADERSHIP

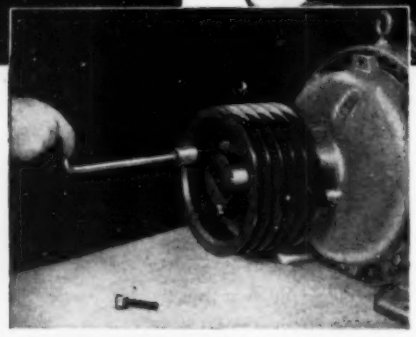
AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

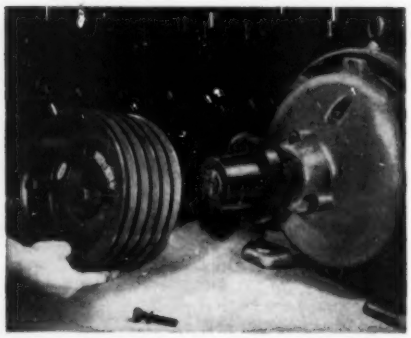
A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N.J., Mitchell 2-8159 • SYRACUSE, N.Y.: 330 Arlington Ave., Phone 76-5068 • CLEVELAND: 5012 Euclid Ave., Room 2007, Express 1-6685
NEW ENGLAND: 1374 Mass. Ave., Cambridge, Mass., Kirkland 7-4478 • PHILADELPHIA: 1649 N. Broad St., Stevenson 4-2823 • ST. LOUIS: 1123 Washington Ave., Garfield 4959
CHICAGO: 228 N. LaSalle St., Central 6-1721 • SOUTHWEST: John A. Green Co., 6815 Oriole Dr., Dallas 9, Dixon 9918 • LOS ANGELES: 5603 N. Huntington Dr., Capitol 1-9114

"O.K., GEORGE. YOU'VE CONVINCED ME THAT A TWO-PIECE SHEAVE GRIPS TIGHTER, BUT I DON'T SEE WHAT DIFFERENCE IT MAKES HOW IT'S ASSEMBLED."
"THE QD IS ASSEMBLED RIGHT ON THE SHAFT, CHARLIE. THAT WAY THE HUB STAYS PERMANENTLY ALIGNED. YOU MERELY REPLACE THE RIM TO CHANGE SPEEDS."



ONLY THE RIM COMES OFF. This is done by using the heavy assembly bolts as jack screws. Then the sheave slides easily off the tapered hub. No time-consuming prying or hammering is required.

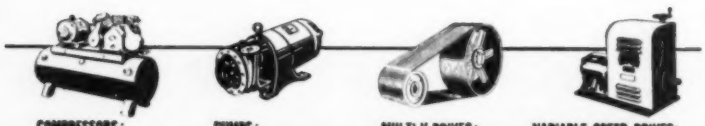


THE HUB STAYS PUT—there's no need to remove it when changing speeds. When you've finished the job, you just replace the rim over it and tighten the bolts. Alignment is *permanent*.

"How it's assembled" makes a big difference when you're choosing sheaves!

Because the famous Worthington QD can be assembled and disassembled right *on the shaft*, your maintenance man can change speeds merely by changing rims. The previously aligned hub need not be touched.

On initial assembly, holding alignment of the hub is a snap. All you do is tighten the flange cap screw after positioning the hub along the shaft. Drifting of the key is prevented by tightening the set screw over the key.

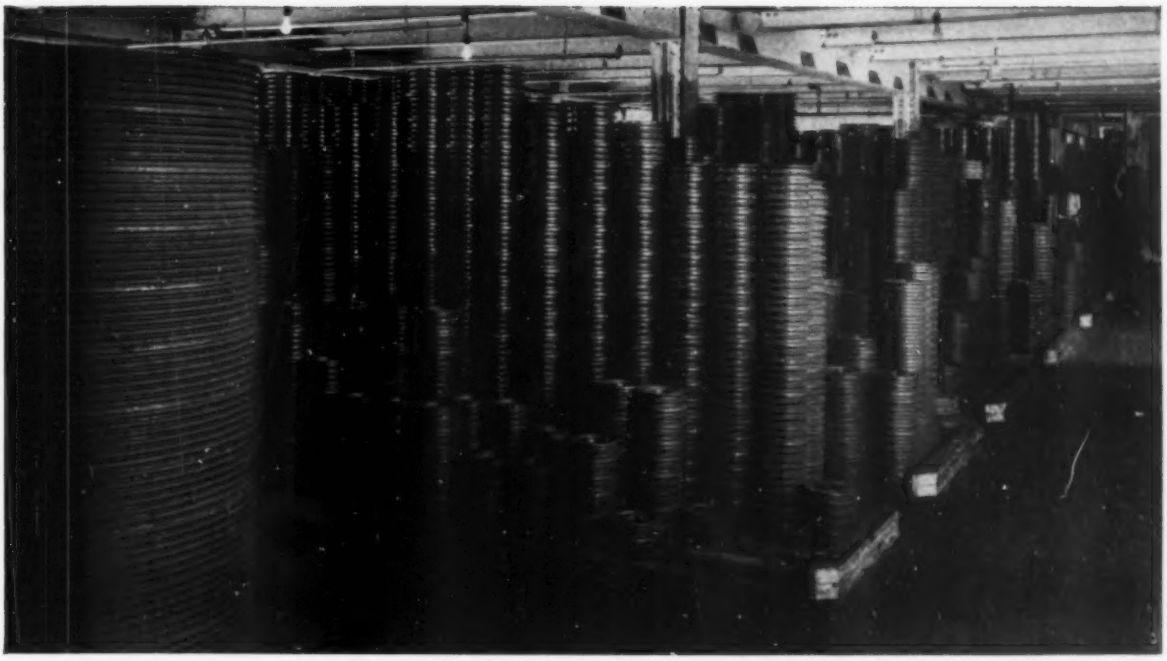


COMPRESSORS: AIR-COOLED, WATER-COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER

MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

VARIABLE SPEED DRIVES: WORTHINGTON ALLSPEED



You don't have to wait for Multi-V-Drive Equipment

WORTHINGTON-GOODYEAR EC CORD V-BELTS are the only belts available with a single parallel row of low-stretch, high tensile, heavy cord to withstand high flexing abuses required of short belts. Tire cord ply construction insures proper transverse rigidity on longer V-belt drives. Steel Cable V-belts and HY-T Super Rated V-belts will handle really tough drives. Prompt service on the complete line.

Worthington stocks a complete line of QD Sheaves, small V-pulleys, and Worthington-Goodyear EC Cord V-belts

Your local Worthington Multi-V-Drive distributor has a complete line of Worthington QD Sheaves, fractional horsepower V-pulleys and Worthington-Goodyear V-belts. He's backed by large factory stocks that enable him to fill your order *immediately*.

The Worthington fractional horsepower line of V-pulleys includes:

The QD Junior V-Pulley that will grip the shaft tighter than any other V-pulley now available. Its tapered hub is forced tight on the shaft and won't loosen due to shock or vibration.

Machined Steel V-Pulleys—3½ inches and under—precision-bored for proper fit. Grooves are accurately cut to provide proper seating of the belt for longer wear.

Pressed Steel V-Pulleys of heavy gauge welded steel. Equal weight distribution assures accurate balance and vibrationless operation.

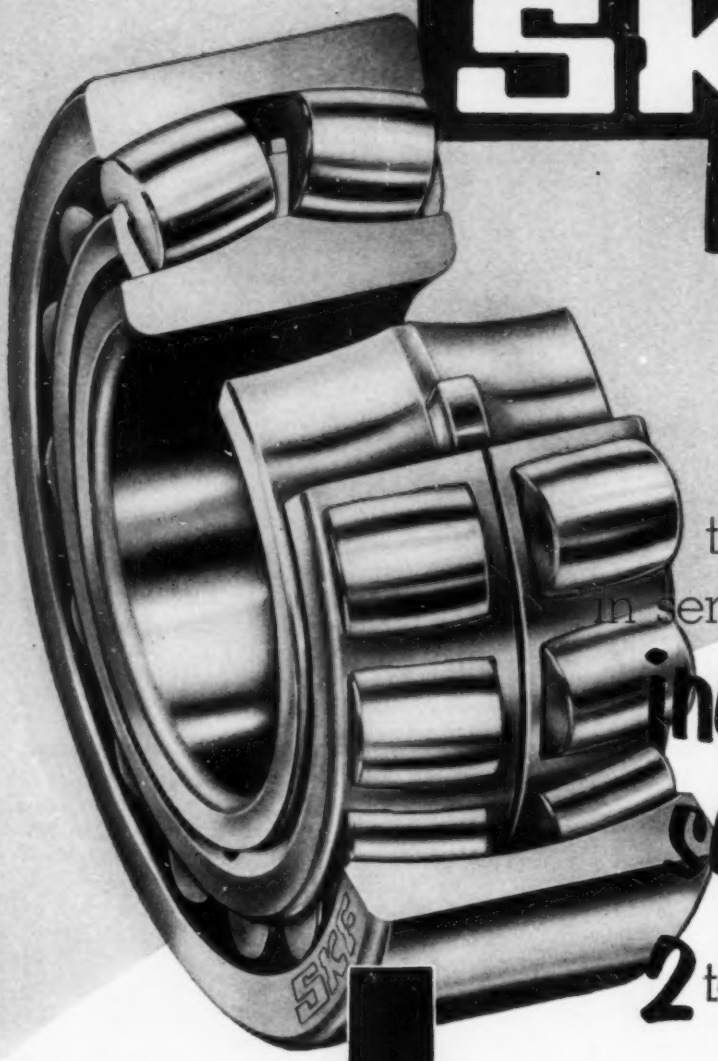
Cast Iron Bored-to-Suit V-pulleys accurately machined for true running and perfect balance. They come in a full range of sizes with one or two grooves.

For prompt deliveries, or further information on any Multi-V-Drive equipment, write to Worthington Corporation, Section MV.3.2, Oil City, Pennsylvania. MV.3.2

Specify These Worthington Standard Products on Your Equipment

WORTHINGTON

SKF Increases



this improvement
in series 222 and 223
increases the
service life
2 to 3½ times

other advantages are important

ECONOMY: When designing new equipment, the desired life can be obtained by using smaller or lighter bearings at considerable cost saving.

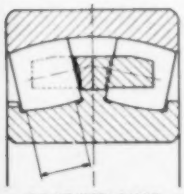
COMBINED LOADS: This great forward step in bearing design provides a Spherical Roller Bearing capable of carrying heavier combinations of radial and thrust loads or pure thrust loads of greater magnitude.

SELF-ALIGNMENT: The important self-aligning feature of SKF Spherical Roller Bearings has been preserved, so that considerable misalignment between the shaft and housing has no ill effect whatever on bearing capacity or life.

© 1953, SKF INDUSTRIES, INC.

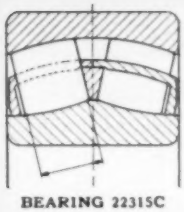
capacity

of spherical roller bearings 25% to 50% by means of improved internal design



BEARING 22315

This is the Spherical Roller Bearing design originated by SKF *more than 30 years ago.* The cross-section shows how the integral inner ring flanges, and the undercuts adjacent thereto, limit the effective length of the rollers.



BEARING 22315C

Here is the *latest* SKF improvement, a ***revolutionary advance in design.*** Effective roller guiding is accomplished by means of a separate ring. This eliminates the need for undercuts! This type of guide ring permits the rollers to take the position which their contact with the rings dictates. This assures uniform load distribution over the entire length of the longer rollers at all times. *Result*—greatly increased capacity and life.

SKF, the originator of the Spherical Roller Bearing, has, here again, provided Industry with another *first* through this improved design. During more than 4 years, thousands of installations have been made in railroad journals, vibrating screens, steel mill machinery and numerous other fields. Performance, in all cases, has been outstanding.

SKF Sales Engineers in our District Offices throughout the country will assist you in making use of the important advantages of the improved internal design of SKF Spherical Roller Bearings.

7428 A

This 12-page booklet gives you additional facts—sizes available—added capacity, size by size—increased life you can expect for each size—dimensional tabulations—and load and speed data. Write for your free copy of Bulletin 365-1 *now.*

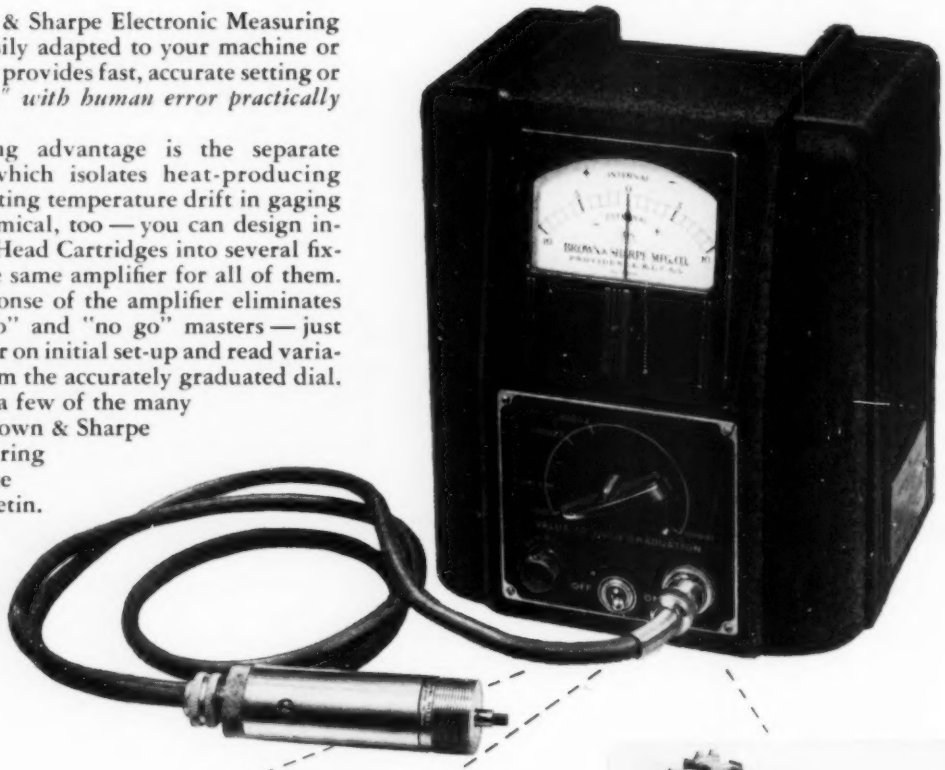
SKF INDUSTRIES, INC., Dept. 616, Philadelphia 32, Pa., *manufacturers of* SKF *and* HESS-BRIGHT *bearings.*

SKF®

BALL AND ROLLER BEARINGS

Build "*tenths of tenths*" measuring into your equipment

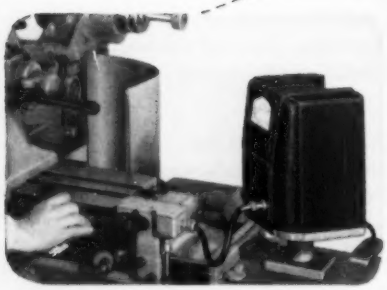
Brown & Sharpe Electronic Amplifier No. 950 for .0001" to .00001" readings. Gage Head Cartridge No. 953 is plugged in.



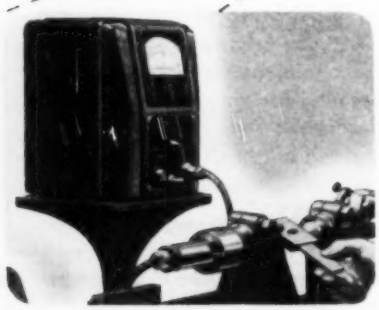
Versatile Brown & Sharpe Electronic Measuring Equipment is easily adapted to your machine or fixture design. It provides fast, accurate setting or gaging to .00001" *with human error practically eliminated.*

An outstanding advantage is the separate amplifier unit which isolates heat-producing elements, preventing temperature drift in gaging units. It's economical, too — you can design inexpensive Gage Head Cartridges into several fixtures and use the same amplifier for all of them. True linear response of the amplifier eliminates the need for "go" and "no go" masters — just "zero" the pointer on initial set-up and read variations directly from the accurately graduated dial.

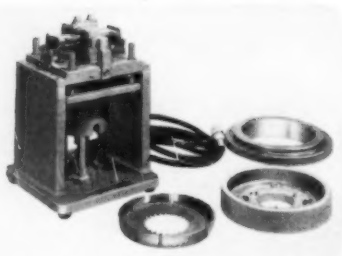
These are but a few of the many advantages of Brown & Sharpe Electronic Measuring Equipment. Write for detailed Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.



Electralign — an application of this precision electronic equipment in Brown & Sharpe's own grinding machines. Permits fast, accurate setting of swivel table for precision grinding straight work or exact tapers after a single trial grind.



Gage Head Cartridge No. 953 mounted on fixture to measure a fixed gage . . . used with Amplifier No. 950. Standard comparators for external or internal measuring also available.

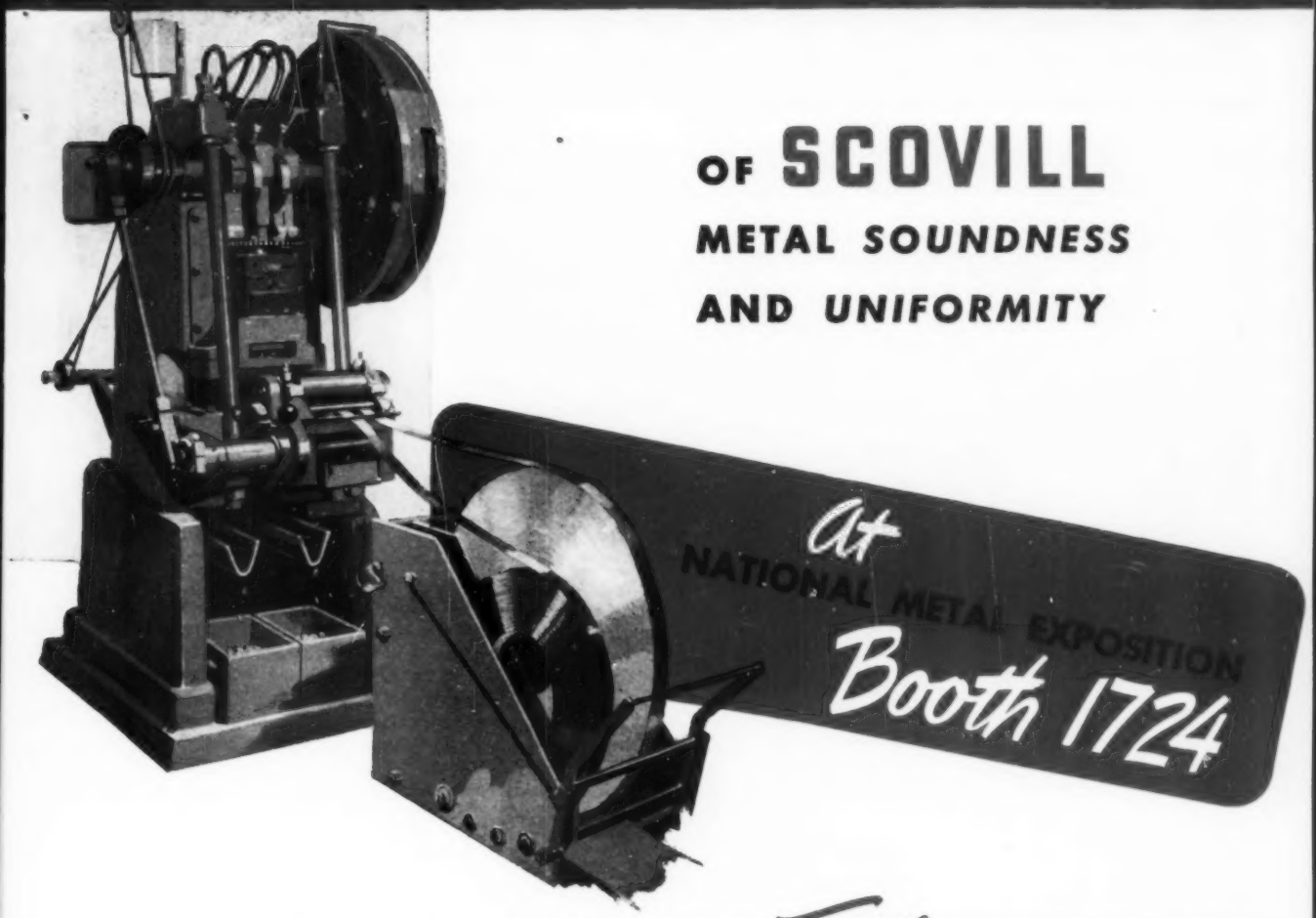


Special fixture utilizes Gage Head Cartridge and Amplifier to measure internal angle accuracy to ± 1½ seconds independently of bore size and without reference to locating surface.

WE URGE BUYING THROUGH THE DISTRIBUTOR

Brown & Sharpe B·S

SEE THIS UNIQUE DEMONSTRATION



OF SCOVILL METAL SOUNDNESS AND UNIFORMITY

SCOVILL BRASS and SCOVILL'S NEW *Truspec* ALUMINUM STRIP RUNNING SIMULTANEOUSLY IN THE SAME PRESS

Metal fabricators . . . long familiar with Scovill's exceptionally close control of inherent soundness and uniformity in Brass Mill Products . . . have sought for equivalent *dependably close* standards in commercial aluminum strip.

Today, we are happy to announce that a NEW Scovill aluminum strip mill *is* producing cold-rolled aluminum strip to your tight specifications, far closer than was once thought possible. Most notable features of this new Scovill TRUSPEC Strip are its remarkably controlled and uniform inherent physical properties — making it possible to minimize "orange peel" effect and "earing."

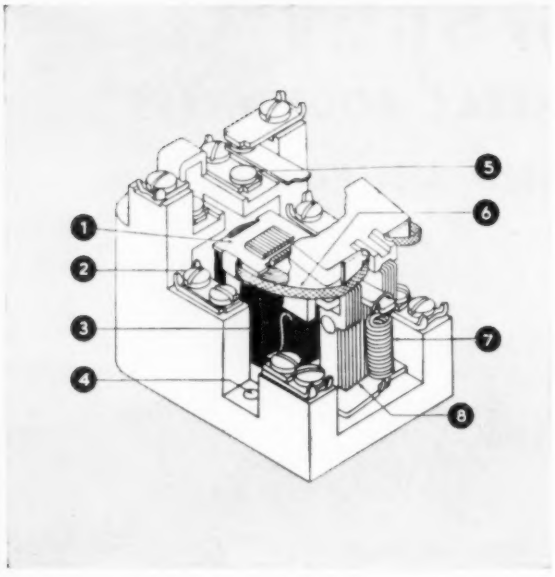
So that you may see for yourself just how closely Scovill's new TRUSPEC Aluminum Strip does approach your ideal, the central feature of our exhibit at the National Metal Exposition will be the unique press operation depicted above. Here similar drawn shells will be produced simultaneously under production-line conditions from giant coils of Scovill Continuous-Cast Cartridge Brass, 70% and Scovill TRUSPEC Aluminum Strip fed into the press side-by-side. Yes, you can see for yourself . . . at Booth 1724 . . . that

You don't gamble — when you use **SCOVILL** *Brass and Aluminum Strip!*

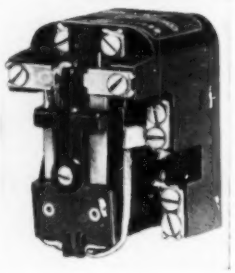
SCOVILL MANUFACTURING COMPANY, WATERBURY 20, CONNECTICUT

109CBA

Designer's



New G-E general-purpose relay gives longer life, added flexibility

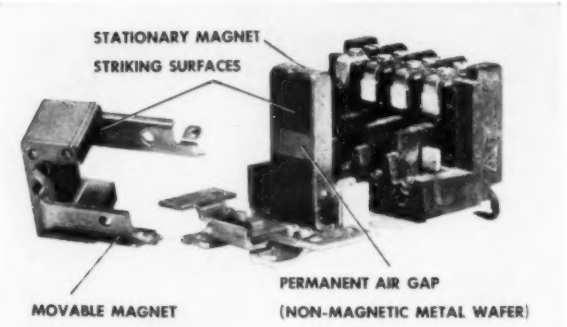


Redesigned with a new, long-life shunt, General Electric's general-purpose relay is ruggedly built for long, dependable operation.

The cutaway view (above) shows the construction that assures top electrical performance. **(1) POLE SHADER** means quiet operation. **(2) PAN-HEAD BINDING SCREW** offers easy wiring. **(3) VARNISHED DIPPED PAPER LAYER WOUND COIL** is moisture resistant. **(4) MOUNTING HOLES** make it simple to install. **(5) HEAVY SILVER CONTACTS** assure long contact life. **(6) NEW LONG-LIFE BRAIDED SHUNT** gives maximum performance. **(7) ARMATURE SPRING** insures positive a-c interruption. **(8) LAMINATED MAGNET FRAME** means extra-long coil life.

Its high current rating, small size, and extremely long life make it especially suitable for jobs where space is at a premium and reliability is of prime importance. Accessories are available in kit form for back-mounting, compound-base mounting or plug-in applications. For complete information, send for Bulletin GEC-257.

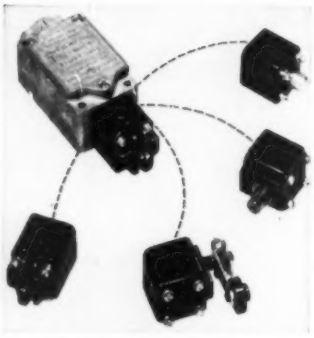
PERMANENT AIR GAP IN G-E STARTERS PREVENTS MAGNETS "STICKING IN"



The General Electric starter has a ***permanent*** air gap, a non-magnetic metal wafer mounted in a stationary magnet structure. Magnets never "stick in" because of residual magnetism. The air gap is built inside the magnet, away from striking surfaces, so the movable magnet can't wear the air gap down, no matter how often the starter is operated.

You're assured reduced maintenance, long mechanical life when you specify G-E magnetic starters. Available in NEMA sizes 0, 1, 2, 3 for a-c motors up to 50 hp. Enclosures include general-purpose, dust-tight, watertight, or explosion-proof. For complete information, see Bulletin GEC-880.

SMALL, VERSATILE G-E LIMIT SWITCHES OFFERED WITH 4-WAY HEAD MOUNTINGS



With General Electric's complete line, you can meet all limit switch needs. This G-E track-type switch (shown from l. to r. with roller push-rod, roller lever, side pushrod, and top push-rod) illustrates the variety of combinations possible from 4 interchangeable heads and a standard body. Each small compact head can be mounted in any of four positions, making 16 combinations. All are easily adjusted and installed because of the simple, basic construction. Check the following Bulletins for the entire G-E limit-switch line: (track-type) GEA-5707, (lever-type) GEA-5705, (rotating-type) GEA-5704.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS

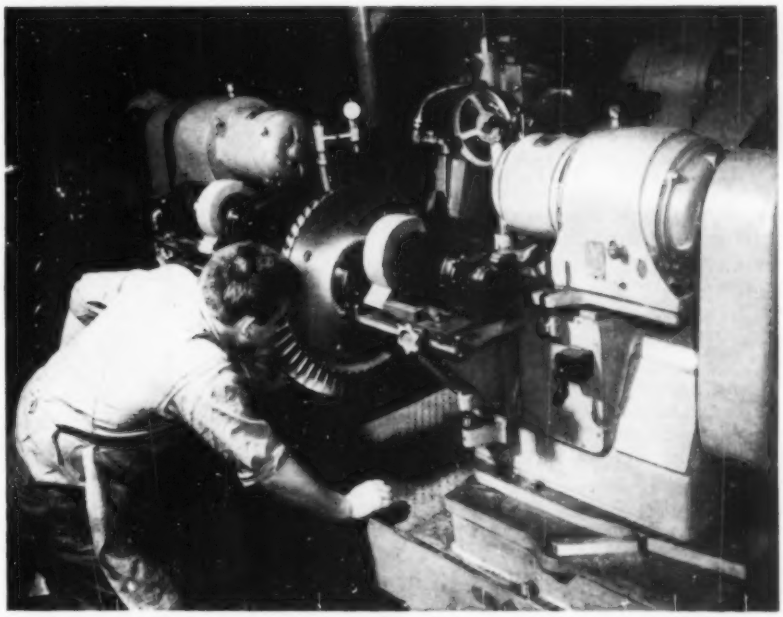
Big selection of G-E gear-motors simplifies any speed reduction job

Dependable single-unit gear-motors meet all your low-speed needs

Your product-motorization problem can be solved quickly with a "packaged" gear-motor—no unnecessary chains, belts or pulleys. General Electric gear-motor's sturdy, cast-iron construction, corrosion- and heat-resistant windings offer you triple motor protection against physical damage, electrical breakdown, and wear and tear.

You get extra motor service from G-E sales and application engineers who are always ready to help you solve your machine-motor problems. A nation-wide network of G-E Apparatus Service Shops are available for fast, dependable service, day and night.

You get help in selecting, too! G-E gear-motor line covers a wide range of power ratings, voltages, speeds, mounting arrangements and enclosures. For help in selecting the right gear-motor, G.E. has set up a comprehensive table, including many typical applications broken down into load and gear-motor class. To get complete information, see Bulletin GEA-1437.



PACKAGED CONSTRUCTION of G-E gear-motors on this machine, which grinds jet-engine bucket blades, cuts installation time, and saves valuable floor space.

BULLETIN GEA-5995 shown above is now available to give you the new NEMA motor standards, including dimension information. As a service to our customers, we will release more details about G-E motors in the new NEMA frames, as such information becomes available.

General Electric Company
Apparatus Sales Div., Sec. C668-106
Schenectady 5, N. Y.

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

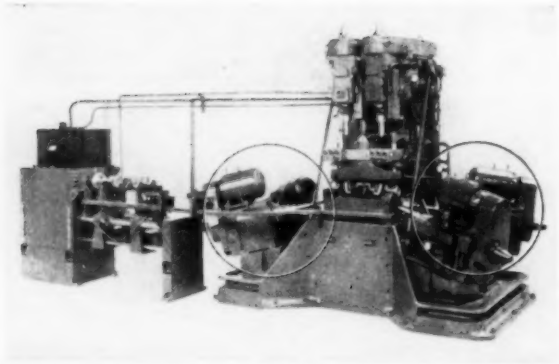
Please send me the following bulletins
√ for reference purposes
X for immediate projects

- ☐ GEA-1437 Gear-motors
- ☐ GEA-3995 NEMA Frame Dimensions
- ☐ GEA-5704 Rotating-type Limit Switches
- ☐ GEA-5705 Lever-type Limit Switches
- ☐ GEA-5707 Track-type Limit Switches
- ☐ GEC-257 General-purpose Relay
- ☐ GEC-880 Magnetic Starters

CONSULT YOUR McGRAW-HILL CATALOG FOR PRODUCT ENGINEERS!
You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____
COMPANY_____
STREET_____
CITY_____ STATE_____

TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS



INCREASED PRODUCTION on this drill press was obtained with G-E Selsyns, which remotely position cams to determine drilling depth.

FLEXIBLE SELSYN SYSTEM PROVIDES AUTOMATIC SYNCHRONIZED CONTROL

General Electric selsyns provide automatically synchronized control from one location. These selsyns are electrically interconnected to synchronize motion at two or more points in the system.

Selsyn systems are flexible because only electrical connections are required. Immediately on application of voltage, all units synchronize automatically. Selsyn systems are economical, require no specially trained operators and offer long service. Dependability is assured because they will maintain their accuracy indefinitely. For full information send for Bulletin GEA-2176.

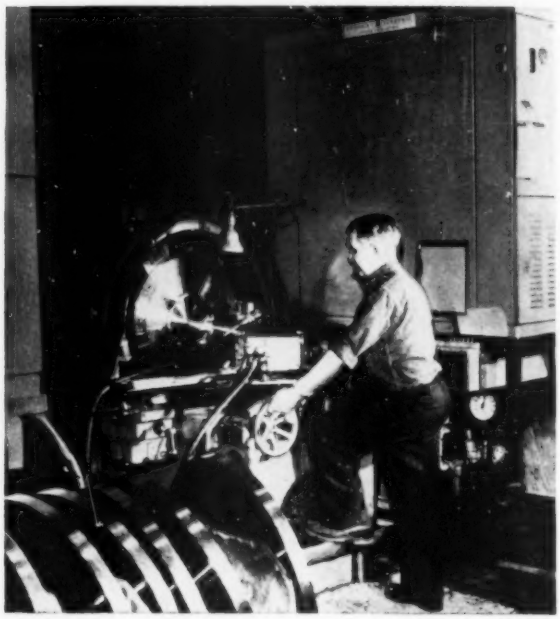
G-E INDUSTRIAL ELECTRONICS COURSE OFFERED IN 12 PRACTICAL LESSONS

This comprehensive presentation offered by General Electric gives plant managers, production men, and electrical or maintenance staffs a practical appreciation and understanding of industrial electronics.

Twelve sound slidefilms, of approximately one-half hour each, outline various types of tubes used in industry. Specific industrial applications, showing both present uses and future possibilities, are also described.

Included in the program material is an instructor's guide plus a completely illustrated review booklet for each film. All are packed in an attractive, durable carrying case. For the full story on the course, see Bulletin GEA-5339.

Packaged G-E Speed Variator gives precise machine control



ACCURATE DRIVE ADJUSTMENT on this grinder offers excellent speed regulation and extraordinary adaptability for grinding a variety of products. Here operator is grinding jet turbine wheels.

Here's where you can put the latest advances in adjustable speed drives to work on your job. By using General Electric Speed Variator you can always match your machine speed to the work with high precision. This stepless speed drive offers increased versatility of machines, boosts output, reduces waste, and improves production quality. Added flexibility of adjustable motor speeds means greatly diversified product output—a wider variety of goods. Speed range is 8 to 1, and under certain conditions as great as 40 to 1.

LET G.E. HELP YOU PICK THE RIGHT DRIVE. For whatever speed-range regulation or special feature you need, there is a G-E adjustable-speed drive for your job. Packaged drives are available from 1/40 to 200 hp—speed ranges from 3 to 1 up to 100 to 1. Send for these informative bulletins.

A. This 26-page manual describes all four types of drives and where to apply them. Bulletin GEA-5334.

B. Lower cost, simplest a-c drive. Bulletin GEA-4883.

C. More flexibility, moderate cost. Bulletin GEA-5335.

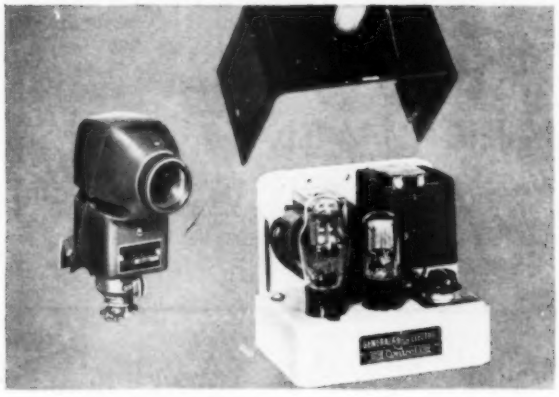
D. Top performance, 1/40–75 hp. Bulletin GEA-5337.

E. High versatility, 1–200 hp. Bulletin GEA-5336.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS



NOW—SIMPLE PHOTOELECTRIC RELAY AVAILABLE FOR A GREAT VARIETY OF JOBS

Versatile General Electric photoelectric relay—available in seven standard combinations of relay and accessories—makes it possible to meet a wide range of applications.

Sturdy construction means dependable operation and extra long service life. Changes in light-level settings are easily made by means of an adjustment knob. And in only a few seconds light source or phototube holder can be focused and aimed.

This G-E photoelectric relay not only provides an inexpensive way to count, control, signal and identify small items, but performs the same service for heavy-duty industrial work. High contact ratings that meet NEMA standards eliminate need for auxiliary relays in most applications. Send for Bulletin GEA-3533.

NEW IMPROVED ULTRASONIC CLEANER SPEEDS DE-GREASING OF SMALL PARTS

Here is a practical answer to the problem of cleaning small, expensive components—the G-E ultrasonic cleaner. Parts are dipped in a suitable cleaning solution and then subjected to ultrasonic energy. Parts are thoroughly cleaned of oil, dirt, and other contaminants from surfaces, corners, and small holes. For further information see Bulletin GEA-5669.

Versatile G-E amplistats meet wide needs in d-c applications

One-volt-ampere amplistat

40-volt-ampere industrial amplistat

Educational-laboratory amplistat

General Electric amplistats amplify tiny control signals—without tubes—to make heavy equipment work faster, more smoothly with greater ease, safety, economy, and reliability.

G-E amplistats offer you broad application possibilities in the design of control and instrumentation systems which require high-gain d-c amplification from a small signal source. They can be used in a wide variety of circuits—singly, in parallel, in cascade or push-pull. Signal windings may be connected separately, in series or in parallel, depending on the signal-source impedance to be matched and the gain and speed of response required.

The G-E line of 60-cycle amplistats is currently being increased by the addition of seven units with ratings of 15-, 40-, 75-, 140-, 325-, 600-, and 930-volt-amperes. These amplistats are for general industrial uses, such as adjustable speed drives and field exciter circuits. Soon a 400-cycle hermetically sealed unit for aircraft application will also be added. For data on available amplistats ask for Bulletin GEA-5950.

General Electric Company
Apparatus Sales Div., Sec. C668-107
Schenectady 5, N. Y.

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

Please send me the following bulletins:

√ for reference purposes × for immediate projects

- ☐ GEA-2176 Selsyns
- ☐ GEA-3533 Photoelectric Relay
- ☐ GEA-4883 ACA Motors
- ☐ GEA-5334 Adjustable-Speed Drives
- ☐ GEA-5335 Speed Variator
- ☐ GEA-5336 Electronic Speed Variator
- ☐ GEA-5337 1/40-75 hp Thy-mo-trol
- ☐ GEA-5339 Electronics Course
- ☐ GEA-5669 Ultrasonic Cleaners
- ☐ GEA-5950 Amplistats

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS!
You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____
COMPANY_____
STREET_____
CITY_____ STATE_____

TEST your HORSEPOWER sense!

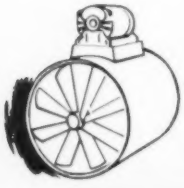
Can you state the H.P. needed for these jobs?

CHECK ONE: ( )1/8-h.p. ( )1/6-h.p. ( )1/4-h.p. ( )1/3-h.p.

Right you are . . . the vast majority of refrigerators contain one-eighth h.p. motors. But did you know that more refrigerators are powered by Delco Motors than by any other make? It's a fact. Manufacturers appreciate Delco dependability!

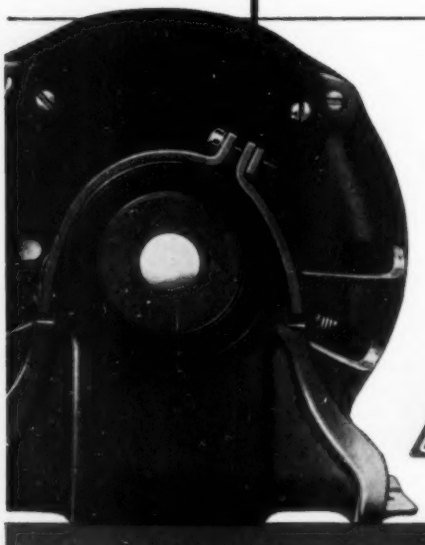
CHECK ONE: ( )1/4-h.p. ( )1/3-h.p. ( )1/2-h.p. ( )3/4-h.p.

Right again! Most washing machines use one-third h.p. motors . . . and more and more manufacturers of washing machines are installing Delco Motors in their products. Delco's dynamically balanced rotor, and Delco's steel-backed babbitt bearing with cored oil wells mean long trouble-free service—always.



CHECK ONE: ( )1/6-h.p. ( )1/4-h.p. ( )1/3-h.p. ( )1/2-h.p. ( )3/4-h.p.

Correct . . . it depends on the size of blower required. So remember: Delco motors for blowers are available in all standard h.p. ratings . . . and Delco motors are favorites with furnace makers, due to their efficient, ultra-quiet operation.



DELCO

The best running mate your product can have!

DELCO PRODUCTS

Division of General Motors Corporation • Dayton, Ohio

SALES OFFICES: Atlanta • Chicago • Cincinnati • Cleveland
Dallas • Detroit • Hartford • Philadelphia • St. Louis • San Francisco

Perspectives~ DESIGN AND DEVELOPMENT

CHANGES FOR ATOMIC ENERGY

Atomic power plants, using nuclear fission as the source of energy, will change philosophies as well as equipment in the power generating industry. Scientists and engineers working to perfect such units are assembling a picture of what the industry will look like in the atomic energy era. Here are some of the things they see:

HIGH QUALITY LOW QUANTITY

- An emphasis on custom tailored high quality equipment instead of mass produced standardized units. Tolerances and quality control will be much stricter than they are today.
- Small companies capable of redesigning their product for every customer will corner a big share of markets for accessories like heat exchangers, pumps, valves, etc.
- Engineering charges for development and design will represent between 50 and 75 percent of new equipment cost.
- More engineers will be required to design, build and operate this equipment.
- Higher skilled mechanics and machinists will be needed to build the reactor units and accessories.

TIGHT SPECS

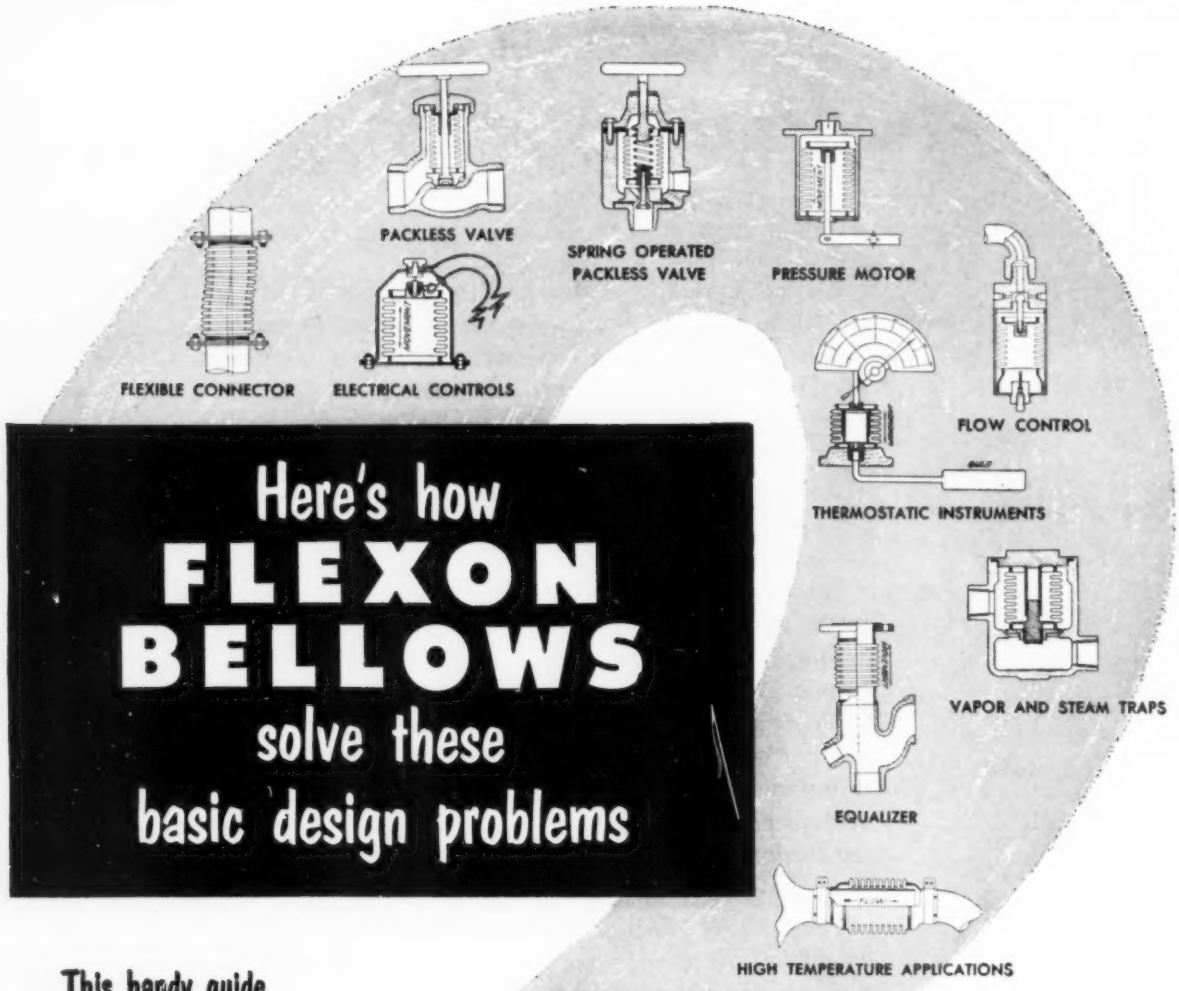
These predictions are the result of experiences gleaned from work on military-sponsored atomic power plants. Atomic scientists claim that the power equipment industry—asked to supply accessories and parts —has had considerable difficulty meeting rigid specifications demanded by the nuclear fission reaction. Many times suppliers thought that the scientists were in error asking for specifications so tight until they saw standards units fail in service. Other suppliers couldn't provide the necessary craftsmanship at reasonable cost.

IMPROVE TECHNIQUES

Since atomic energy opened up the possibilities of tremendous markets, most companies have been trying to decide what action they should take to assure themselves a place in this new field. One scientist, with reason to know, gave *Product Engineering* the answer. When asked if a heat exchanger manufacturer, as a typical example of a supplier, should have some knowledge of nuclear physics to supply equipment for atomic power plants, this researcher snorted, "It would be better if they knew how to weld."

Most of the men who have helped in the development of atomic units second this view. They say that companies will have to improve basic production techniques considerably if they are to meet the demands for atomic energy equipment.

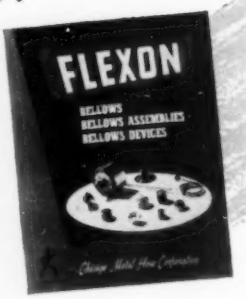
(Continued on page 125)



Here's how FLEXON BELLOWS solve these basic design problems

This handy guide will help you . . .

The Flexon Bellows Design Guide offers useful application data and basic specifications on Flexon brass and stainless steel bellows. If you do not already have a copy, write for yours today, or see Flexon Bellows specifications in Sweet's File for Product Designers.



In any product that requires a motion controlled by temperature, or where a shaft or similar part must be sealed without packing, Flexon Bellows will answer the problem—and assure quality performance.

Flexon Bellows are manufactured by advanced methods to combine economy with exceptionally high standards of uniformity. They are available in brass, bronze or stainless steel in a complete range of sizes to meet virtually any need. For unusual applications, Flexonics bellows engineering specialists will be pleased to assist you. For quotations or recommendations, just send an outline of your requirements.

Flexonics *Corporation* **FLEXON BELLOWS DIVISION**
1351 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows

MATERIALS PROBLEM

Another problem is how to get the proper materials included in accessories. It is necessary for parts in certain places to be free of manganese, tungsten, iron, aluminum, or some other common base or alloying metal. Large companies have difficulty supplying the small quantities of special materials needed. For instance, it just isn't economical for a big pipe mill to supply forty feet of special alloy pipe, rolled to tight tolerances—they're set up to handle orders for hundreds of miles of pipe. That's one of the big reasons why scientists predict a rise in the number of small suppliers.

Control equipment and instrumentation have supplied reactor builders with still another headache. Here the difficulty is reliability. Electronic circuits, and vacuum tubes particularly, have not been able to meet the demands of such service.

MARKETS

These problems are a tipoff as to how big the atomic energy market will be. Scientists are now convinced that many estimates have been too optimistic. Rather they think there will be only two really large fields: marine propulsion and central station generating units.

Atomic power units seem a sure bet to take over a major share of future ship propulsion installations. Tests on the land-based prototype of the U. S. Navy's submarine power plant have proved that the reactor is a practical way to supply energy aboard ship, even on commercial vessels. The big advantages: increased range and increased pay load because of reduced fuel weight.

The future of land-based commercial generating equipment is harder to predict. There isn't enough complete data to draw any real conclusions. What's needed, of course, is a pilot plant capable of producing electricity on a large enough scale so that economic and technical factors can be studied.

Some other prospects for atomic energy—aircraft and automotive units—look like wishful thinking at this date. It's possible that military aircraft, powered by reactor, might be developed because of the increased range. But it's doubtful if commercial aircraft or automotive engines would be practical. The major obstacles: the weight of shielding required, and the scarcity of fissionable fuel.

NEW ENERGY SOURCES

Many scientists feel that better sources of energy will be developed before an airborne reactor unit is perfected. Behind this belief is the opinion that nuclear fission is only a temporary source of power. It is a means of bridging the gap between fossil fuels like coal and petroleum, and some infinitely abundant source of power like solar radiation or the thermonuclear (H-Bomb) reaction.

LIVE WITH NEUTRONS

Industry's number one enigma today in atomic energy is learning to live with the neutron. Because atomic energy was first associated with a bomb, many people—including engineers and scientists—have developed a reverential awe of the subject. Because much publicity was given to the radiation effects of atomic energy, many people have developed a fear of it.

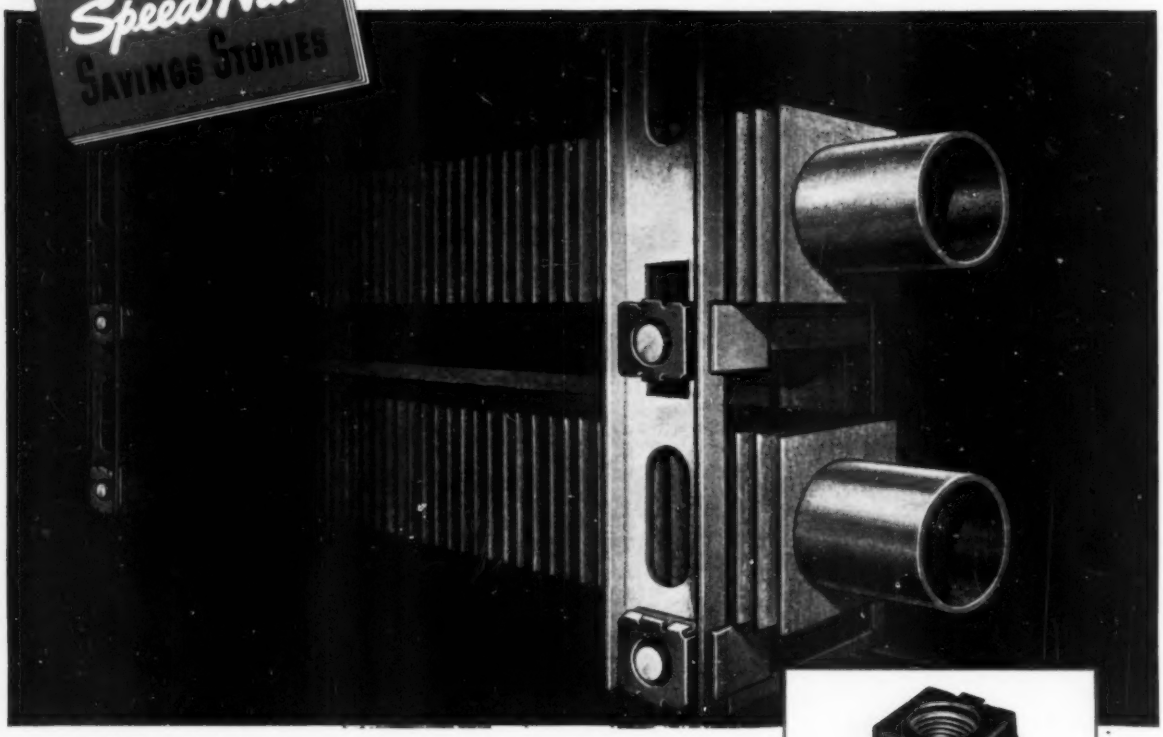
Those with as much as five years experience on atomic power plant work claim that working with neutrons, beta and alpha particles is no more dangerous than any other industrial hazard. They feel safer working with the neutron than with process steam or high octane gasoline.

FASTEST THING IN FASTENINGS®

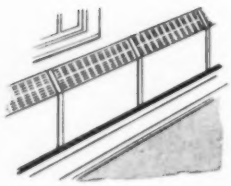
TINNERMAN

Speed Nut

SAVINGS STORIES



radiant-ray saves 78% with Tinnerman SPEED GRIPS®



Reducing the cost of assembling enclosures to Airfoil Finned heaters was a double problem for Engineers at Radiant-Ray Radiation, Inc., New Britain, Conn. Easier ways of installing the units had to be considered also. On both counts SPEED GRIP nut retainers turned the trick over all other methods! These SPEED NUT brand fasteners saved 78% in production time, machining costs, and materials . . . permitting the use of less costly channel, eliminating punching and tapping of holes on wall hangers, and doing away with the longer flange on the expansion cradle hanger.

One leading contractor has this to say about easier, faster custom-fitting and installing: "Adjusting and levelling are now a 'snap' for us due to these SPEED GRIPS." Your Tinnerman representative is trained to help you spot savings opportunities like this on your product assemblies. See him soon!

Tinnerman SPEED GRIP® Nut Retainers...

snap into place by hand. Provide heavy-duty fastenings . . . eliminating welding, clinching, or staking. Reduce materials and materials handling; ideal for blind locations. Complete range of sizes available!

Write today for your "SPEED NUT Savings Stories" booklet of typical Tinnerman savings to industry: TINNERMAN PRODUCTS, INC., BOX 6688, Dept. 12, Cleveland 1, Ohio.

In Canada: Dominion Fasteners, Ltd., Hamilton, Ont. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S.A.—7 rue Henri Barbusse, Levallois (Seine).

Picturing the Brain Child

SUPPOSE that Leonardo da Vinci had been forced to use the services of a publicity or sales agent to get a contract to paint The Last Supper? Assume also that after Mr. da Vinci had spent hours of sketching and describing his proposed work of art, the non-artist salesman would try to convey the idea to "the powers that be" to "put across the deal." Imagine the result if the salesman had been color blind.

Now let it be further assumed that the "powers that be" were not experts on art either, though they were well versed in it. And they listened with great patience and respect to the salesman who tried so hard to put across "the great idea". By this time, a third hand was receiving a second hand idea. It is safe to conclude that the answer to the proposal to do the painting would have been emphatically "No!" There would have been no job for Leonardo.

Fortunately for posterity, that is not the way things went. Leonardo da Vinci had already made his mark as a great painter. Although the people for whom he worked could not fully visualize the creations that da Vinci proposed, they felt certain that the final result would exceed all expectations. For it is utterly impossible for any artist to explain to a layman a true picture of the work of art he has in mind. Two such minds have little or nothing in common; they do not speak the same language, the same words have different meanings to each of them. When the artist speaks of "ultramarine blue", the layman's mind might well conjure up a picture in deep purple.

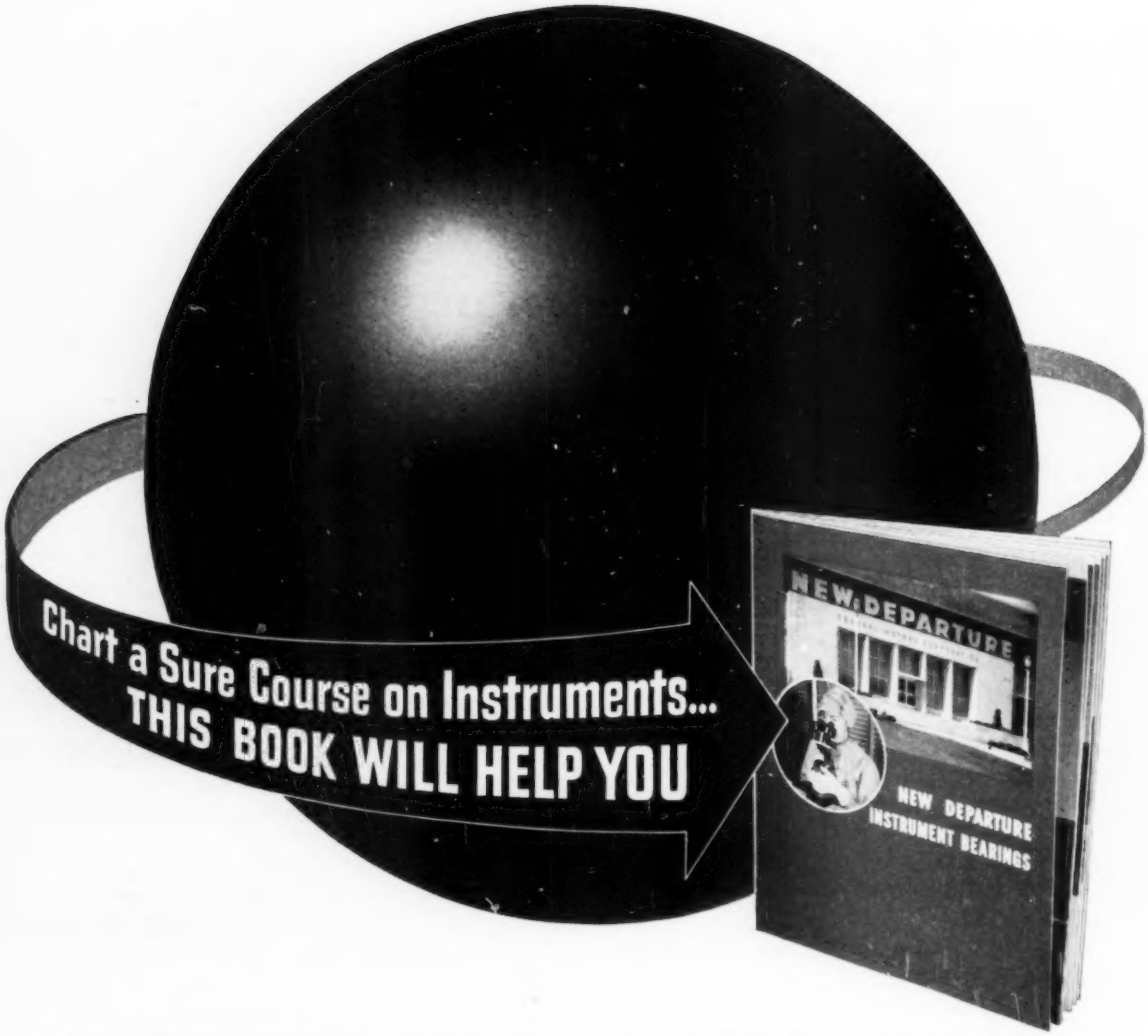
Yet, even if da Vinci had described what he had in mind to another great painter, if he had taken great pains to show him how the painting was to be executed, if he had drawn sketches, labeled in the colors, given voluminous detailed instructions, and asked him to do the job—the resulting picture would have had no resemblance to The Last Supper. Even experts find it extremely difficult, well nigh impossible, to convey their ideas to one another because a work of art reflects the mind and soul of its creator.

Ideas are not tangible or material. They can be described only vaguely. Only too often there is created in the mind of the hearer a vision which is almost the opposite of that intended. Often the refusal or failure of an administration to support a wonderful idea is but a reflection of the inability of the administration to listen, analyze correctly or understand. Usually it is the last. The languages of the idea man and the executive have little in common. But if a man's reputation concerning his abilities to achieve the proposed objective is great enough, it is usually not necessary for him to describe his idea to the satisfaction of others to get their support.

The engineer should not throw up his hands in disgust when his brain child is turned down by management. Perhaps the engineer has not yet built his reputation to sufficient heights to warrant the blind confidence of his management. Or perhaps the engineer has not resorted to the proper techniques by which to paint in the minds of his management, a true picture of his proposal. And finally, who knows but the proposed idea might have been properly understood and in truth is utterly impractical? After all, management is more often right than wrong, otherwise there would be no company.

It often takes considerable ingenuity to convey to the minds of management an exact picture of an idea. And it is unreasonable for the engineer to blame management when he fails to translate the idea correctly. There is only one answer for the engineer: try and try again, each time using different methods, different approaches.

George F. Jordenholt



Strict quality control keynotes every step in the manufacture of New Departure instrument bearings. The book pictured above takes you through New Departure's instrument bearing manufacturing facilities, showing the measures taken to achieve the closest possible approach to perfection. You'll see that New Departure enforces the most exacting standards—from raw material to finished product, to bring you the very finest bearing for *every* instrument application.

If you design or manufacture products demanding high-precision instrument bearings, this book will interest you. Write for your copy—and for the complete instrument bearing catalogue—to New Departure, Bristol, Conn.

NOTHING ROLLS LIKE A BALL

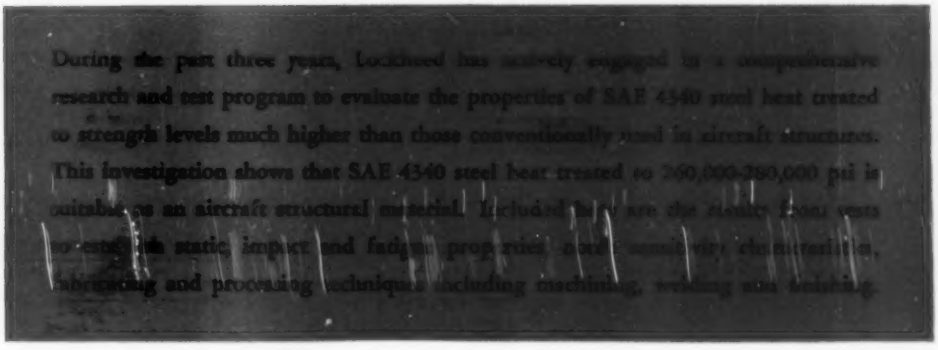
Automatic torque testers measure starting characteristics of every low-torque bearing. It is just one of many exacting control devices developed by New Departure engineers specifically for instrument bearing manufacture.

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Also Makers of the Famous New Departure Coaster Brake

Ultra High Strength Steel for Aircraft Structures


During the past three years, Lockheed has actively engaged in a comprehensive
research and test program to evaluate the properties of SAE 4340 steel heat treated
to strength levels much higher than those conventionally used in aircraft structures.
This investigation shows that SAE 4340 steel heat treated to 260,000-280,000 psi is
suitable as an aircraft structural material. Included in the

M. A. MELCON
Lockheed Aircraft Corporation, Burbank, Calif.

THE PRECISE NATURE of aircraft designs has always led engineers to exploit the inherent strength characteristics of available materials. This has been true of aluminum and magnesium. High strength alloys were developed and special techniques such as artificial aging and pre-stressing were perfected to obtain optimum strength-weight ratios. Every possible effort was exerted by both the airplane manufacturers and the material suppliers to extract the last available ounce of strength from these light metal alloys.

In the case of steels, little advancement along these lines took place until recently. Despite the fact that only a fraction of the possible static strength of steel elements has been utilized in design, very little emphasis has been placed upon full utilization of the potentially advantageous strength-weight ratio of alloy steel. Yet steel, unlike the lighter alloys, requires only a slight change in heat treat schedule to cause appreciable increases in mechanical properties.

Probably the most important single factor influencing this failure to make use of the potentially high strength characteristics of alloy steels is that aircraft designers have long been under the impression that brittleness is an inherent characteristic of hard steels. It has been generally accepted that static strength in excess

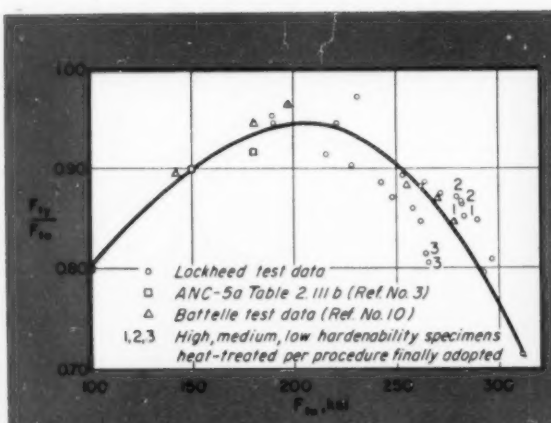

Lockheed test data
ANC-5a Table 2.111 b (Ref. No. 3)
Battelle test data (Ref. No. 10)
1,2,3 High, medium, low hardenability specimens heat-treated per procedure finally adopted

Fig. 1—Ratio of tensile yield to ultimate tensile strength for SAE 4340 steel at various strength levels.

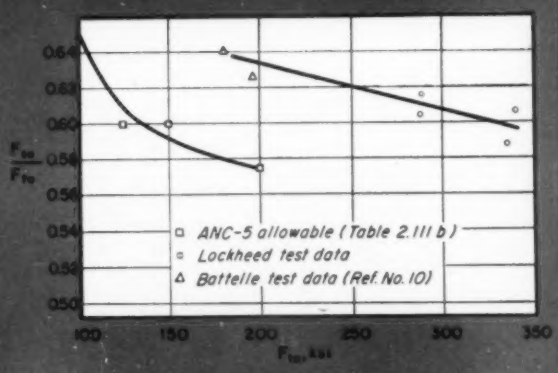


Fig. 2—Ratio of ultimate shear to ultimate tensile stress at various strength levels.

of 200 ksi could not be used because of attendant problems of brittleness, notch sensitivity and fatigue life. The results of recent investigations have indicated that these beliefs are not valid.

Lockheed's California Division has conducted an elaborate test program to evaluate SAE 4340 steel heat treated to strength levels much higher than those associated with conventional aircraft structures. These studies were given their early impetus by the introduction of a propriatary material called Hy-Tuf[1] for which was claimed ultra high strength combined with toughness. The mechanical properties of this alloy were determined and a comparative evaluation made with standard alloy steels such as SAE 4340.

The results of these comparative evaluations were surprising. The new material lived up to the claims which had been made for it, and, contrary to all preconceptions, the so-called 'toughness' characteristics of SAE 4340 steel at high strength levels were also found to be entirely satisfactory for aircraft structures. In fact, SAE 4340 could be heat treated to appreciably higher strength levels. Test data showed that the notched fatigue strength of both steels increased with increasing ultimate static tensile strength. This was true throughout the entire range investigated except for the low cycle range of the curve for specimens having a notch which

Table I—Properties for Specimens of Various Hardenabilities Heat Treated According to Adopted Procedure

(All specimens machined from 2 in. square bar and normalized at 1,600 F for 4 hr, austenitized at 1,475 F for 4 hr, oil quenched and tempered for 8 hr)

Hardenability[1]	Tempering Temp, F	F_{tu}, ksi	F_{ty}, ksi	Elong, % in 2"	Red. Area, per cent
A	500	280.1	241.4	9.5	39.0
		281.4	242.8	9.5	36.5
B	450	278.0	242.0	11.0	41.0
		281.0	244.0	10.0	40.5
C	400	264.0	214.6	7.0	26.0
		266.0	212.6	7.0	27.0

[1] Hardenability Data

A	B	C
$J_1 = 59.5$	$J_1 = 58.0$	$J_1 = 57.5$
$J_{20} = 58.0$	$J_{20} = 56.0$	$J_{20} = 51.5$
$J_{32} = 58.0$	$J_{32} = 49.0$	$J_{32} = 46.0$

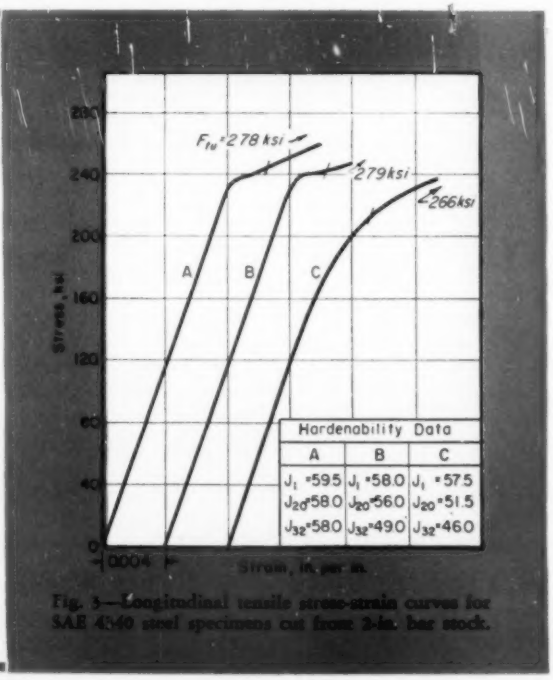


Fig. 3—Longitudinal tensile stress-strain curves for SAE 4340 steel specimens cut from 2-in. bar stock.

produces an effective elastic stress concentration factor, K_t, of 3.0. In this low cycle range of the $K_t = 3.0$ curve, the fatigue strength remained substantially constant as the static strength was increased. Static tests indicate that the elongation and reduction in area of SAE 4340 heat treated to 260-280 ksi are only slightly less than at 180-200 ksi, and that even the Izod impact strength is not significantly reduced as regards aircraft applications.

Although the available laboratory test data indicate that SAE 4340 steel heat treated to the 260-280 ksi strength level is eminently suited to aircraft structural applications, there have been a few reports of service difficulties which were attributed to high heat treat. When the facts surrounding these cases are fully assembled, they invariably indicate rather weak evidence that the primary source of the trouble is high heat treat. The real cause is obscured since remedial action usually involves changes in geometry, increases in material gages, revised processing procedures, and reduction in heat treat level. In all of these cases which have been investigated, it has not been possible to say definitely that any one factor was the cause of failure, nor conversely that any one change produced the desired corrective and beneficial action.

STATIC PROPERTIES

When preliminary investigation indicated that SAE 4340 steel heat treated to the 260-280 ksi ultimate static strength level was satisfactory for use in aircraft structural components, two steps were taken. First, a heat treat schedule that would consistently reproduce a minimum tensile strength of 260 ksi and result in optimum yield strength, reduction of area and elongation was established. Then with the proper heat treatment procedure known, the mechanical properties associated with the new ultimate static tensile strength level were determined.

The mechanical properties of any given piece of alloy steel are dependent upon its micro-structure, which is dependent upon three closely related factors: chemical composition, heat treatment and geometry of the piece under study. If two pieces of a given alloy steel possess identical microstructures, they will also have the same mechanical properties, which bear definite relationships to one another. Unfortunately, these relationships are not fixed because they change slightly with variations in static strength level. At any specific level, however, the ratios of the various mechanical properties to the ultimate tensile strength are substantially constant, provided the heat treatment utilized in attaining that strength level consistently reproduces the microstructure.

Step #1, therefore, necessitated extensive tests of SAE 4340 specimens heat treated in accordance with several different schedules. From these tests were formulated procedures for heat treat operations that produce not only the desired minimum static ten-

Table II—Mechanical Properties of SAE 4340 Steel Heat Treated to 260–280 ksi

Property	Allowable (ksi)
F_{tu}	260
F_{ty}	208
F_{cy}	208
F_{su}	152
F_{bru} $(e/d = 1.5)$	366
F_{bru} $(e/d = 2.0)$	462
F_{bry} $(e/d = 1.5)$	348
F_{bry} $(e/d = 2.0)$	402
E	29,000
E_s	29,000
G	11,000
W (lb/in.³)	0.283

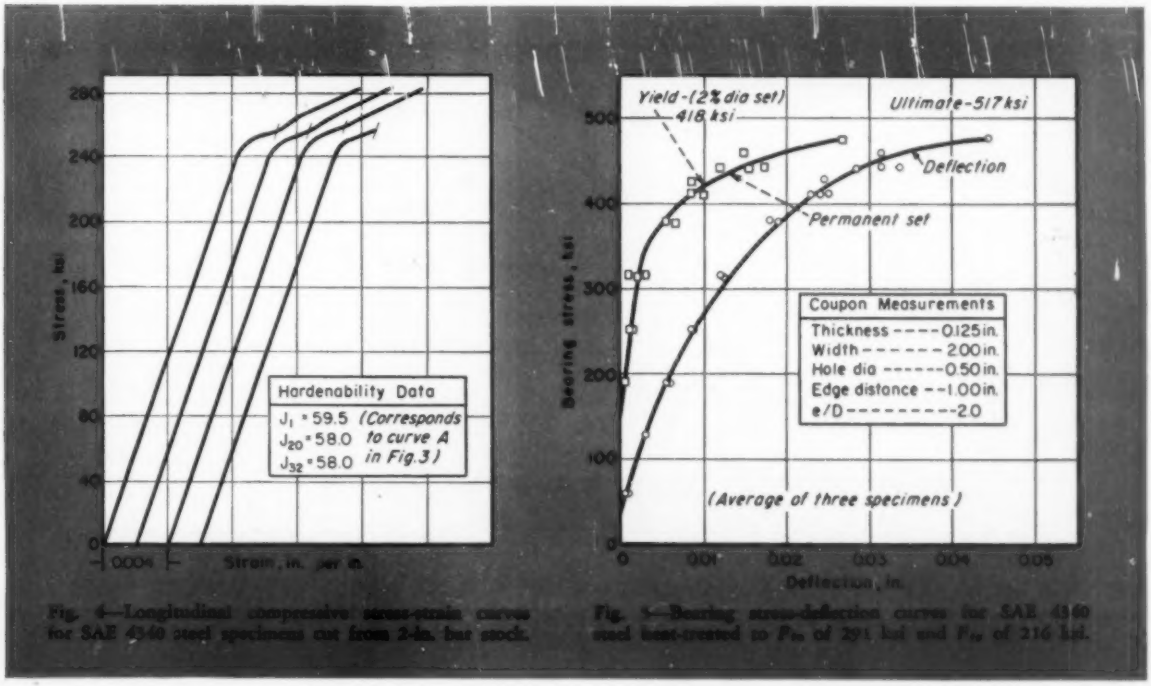


Fig. 4—Longitudinal compressive stress-strain curves for SAE 4340 steel specimens cut from 2-in. bar stock.

Fig. 5—Bearing stress-deflection curves for SAE 4340 steel heat-treated to F_{tu} of 291 ksi and F_{ty} of 216 ksi.

sile strength, but also a stable reproducible micro-structure. Step #2 consisted of a relatively small number of tests to determine the ratios of the various mechanical properties to the static tensile strength.

It became apparent during the early tests that, at high strength levels, the variations in chemical composition permitted by material specifications can result in considerable variation in mechanical properties. This is no reflection on the basic properties of material heat treated to high strength levels, but merely indicates that, at such strength levels, special procedures are necessary to insure that the mechanical properties fall within the relatively narrow band of hardness (or strength) values adopted for design.

To accomplish this objective, the following procedure was established. Essentially, it consists of normalizing, austenitizing, quenching in oil, tempering at various temperatures depending upon the hardenability of the part being heat treated, and baking at 250 F for 24 hr to stabilize the retained austenite. Based either on the as-quenched hardness or hardness data furnished by the steel suppliers, the material to be heat treated is classified as "low," "average" or "high" hardenability and is tempered at one of three different temperatures corresponding to those hardenabilities.

Though these tests as used to establish an acceptable heat treat schedule had to bracket a wide band of tempering times and temperatures, only a narrow section of this band was adopted. Consequently, only a small portion of the information is representative of what will be encountered in production. Data that pertain to specimens heat treated in accordance with the method finally adopted at Lockheed are reproduced in Table I. These figures show that the elongation and reduction in area are only slightly less than the corresponding properties at the 180-200 ksi strength level. All specimens exhibited so-called ductile fractures.

A summary of the basic minimum mechanical properties of SAE 4340 steel heat treated to the 260-280 ksi strength level appears in Table II. Figs. 1 and 2 show plots of the tensile yield strength and ultimate shear strength vs. ultimate tensile strength. Figs. 3 and 4 contain tension and compression stress-strain curves, and Fig. 5 bearing stress vs. deflection data. The curves in Fig. 3 are representative of the three tempering temperatures and include, in addition to an "average" stress-strain plot, curves which represent the highest and lowest hardenabilities likely to occur in material produced under existing procurement specifications. Also, although the compression curves of Fig. 4 are for the "high" hardenability specimens (corresponding to curve *A* in Fig. 3), the compression yield strength is appreciably higher than the tension yield strength for all specimens tested. Despite this fact, both tension and compression yield have been taken as 0.80 F_{tu} in Table II which lists the values recommended for use in design and stress analysis.

In addition to the basic material allowables enumerated in Table II, design allowables such as plastic bending limits; bending, torsional and transverse shear strengths of round tubing; and column allowables are required for design and stress analysis purposes. These data have been developed by theoretical methods and checked by spot tests as is done for steels at the presently-used lower levels and other materials. Figs. 6-10 show these design data for the 260-280 ksi static strength level.

IMPACT PROPERTIES

Impact strength has been generally accepted as one of the more desirable "toughness" characteristics of structural aircraft materials. But the degree of impact "toughness" which makes a given material suitable for aircraft usage is indefinite and no generally accepted criteria for evaluating im-

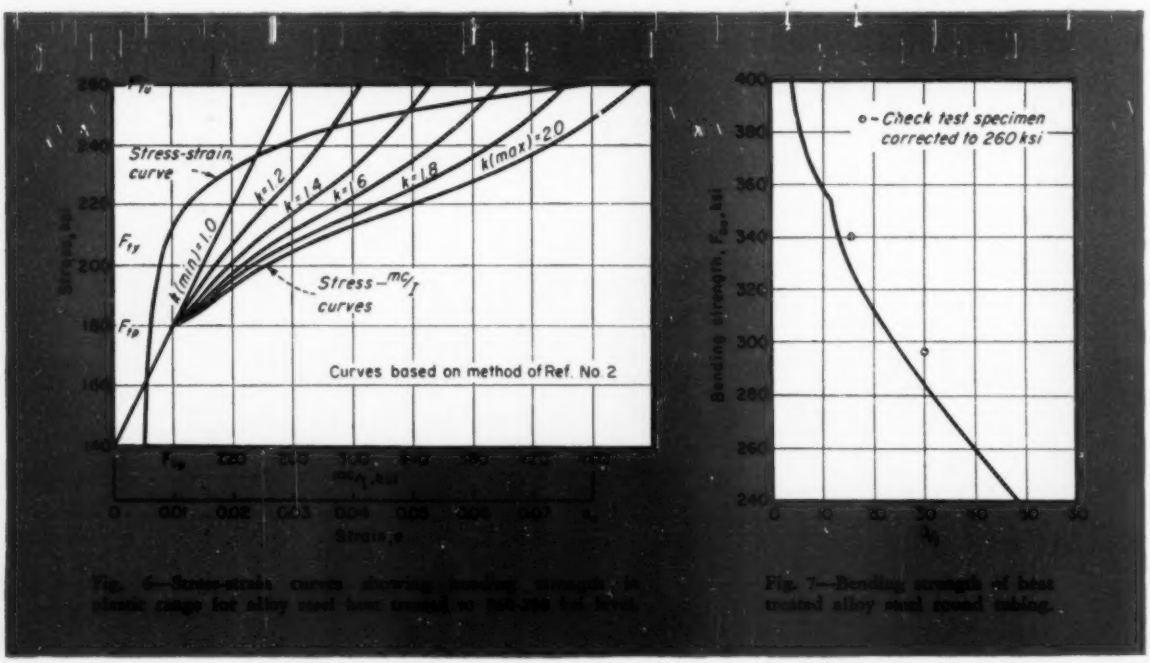


Fig. 6—Stress-strain curves showing bending strength in plastic range for alloy steel heat treated to 260-280 ksi level.

Fig. 7—Bending strength of heat treated alloy steel round tubing.

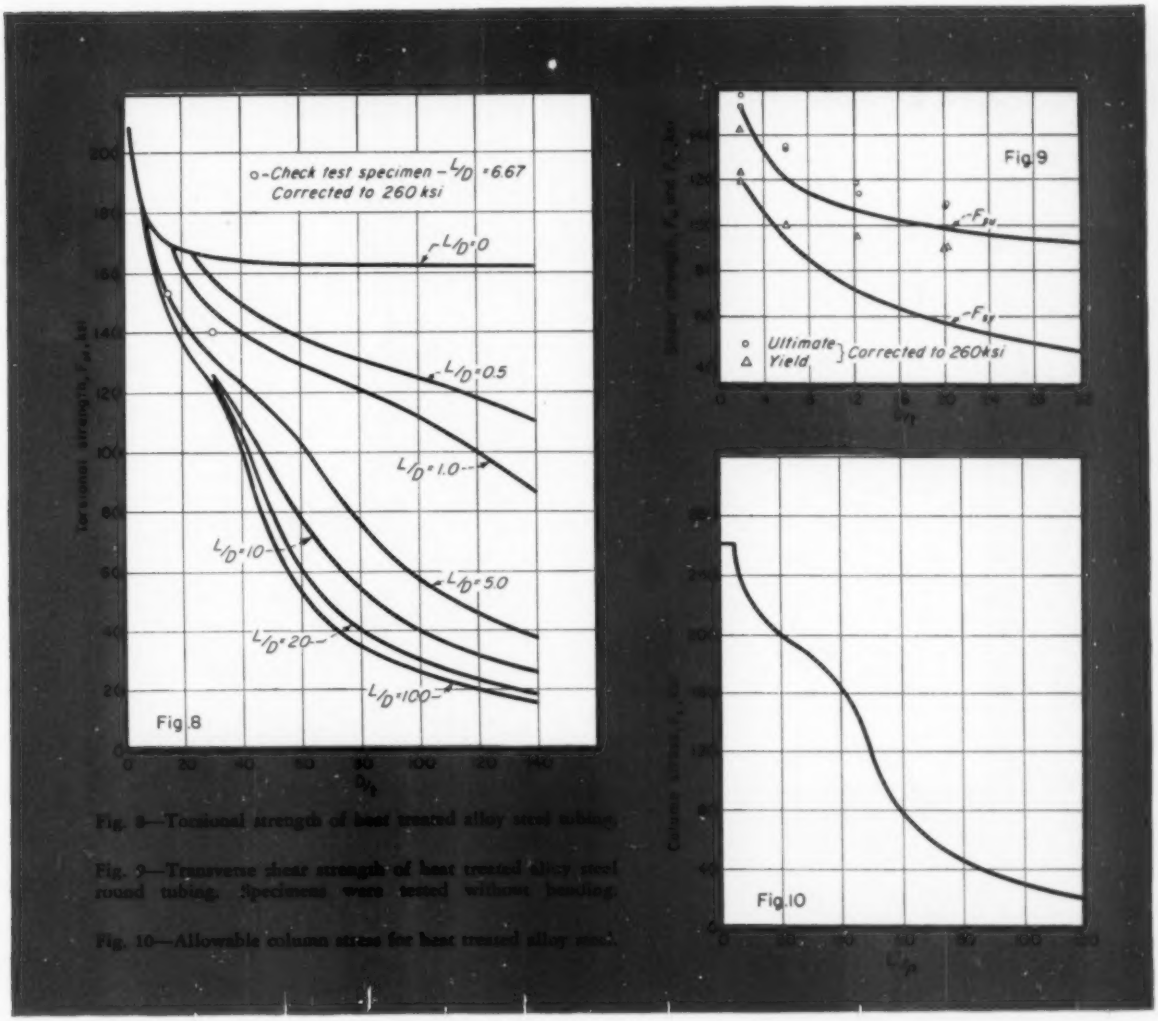


Fig. 8—Torsional strength of heat treated alloy steel tubing.

Fig. 9—Transverse shear strength of heat treated alloy steel round tubing. Specimens were tested without bending.

Fig. 10—Allowable column stress for heat treated alloy steel.

pact strength are available. Payson and Nehremberg have stated that a V-notch Izod impact strength of about 25 or 30 ft-lb would probably be considered acceptable for most aircraft applications. Since the room temperature Izod strengths of 75S-T and 24S-T are 2.5 and 7.8 ft-lb, respectively, it would appear that 25 to 30 ft-lb is unduly conservative. In addition, available methods of measuring impact strength are inherently incapable of consistent results, and very little correlation exists, not only between the notched impact strengths of different materials, but also between impact strengths of identical materials when measured on different testing machines.

More important is the impracticality of interpreting impact test results in terms of aircraft design. This is because true "impact" loads of the type produced in impact tests machines are not encountered in present-day aircraft. Landing loads are the closest approach to impact loading, but when transmitted through tires and other energy absorbing devices, they can hardly be considered "impact" loads in the sense that a pendulum imparts impact to a Charpy or Izod specimen. It is highly questionable, therefore, whether impact strength measurements should be utilized in evaluating materials for aircraft applications.

In the final analysis, considerations of whether a given material does or does not possess a particular property should be tempered with thoughts as to whether that property is actually required in the finished product. Concrete, for example, has extremely poor tension characteristics, yet it is satisfactory in applications subject only to compression loads. In like manner, the fact that steel heat treated to 260-280 ksi ultimate tensile strength possesses somewhat reduced notched impact strength should not preclude its use in applications where impact loads of the type produced in present impact testing machines are not encountered.

All arguments notwithstanding, tests were made at Lockheed to evaluate the conventional impact properties of SAE 4340 at various strength levels. These tests include Izod impact, tension impact, elongation and reduction of area measurements (from tension impact specimens) for alloy steels at various strengths levels ranging from 160 to 270 ksi. Izod and tension impact data for SAE 4340 steel are summarized in Fig. 11. Here

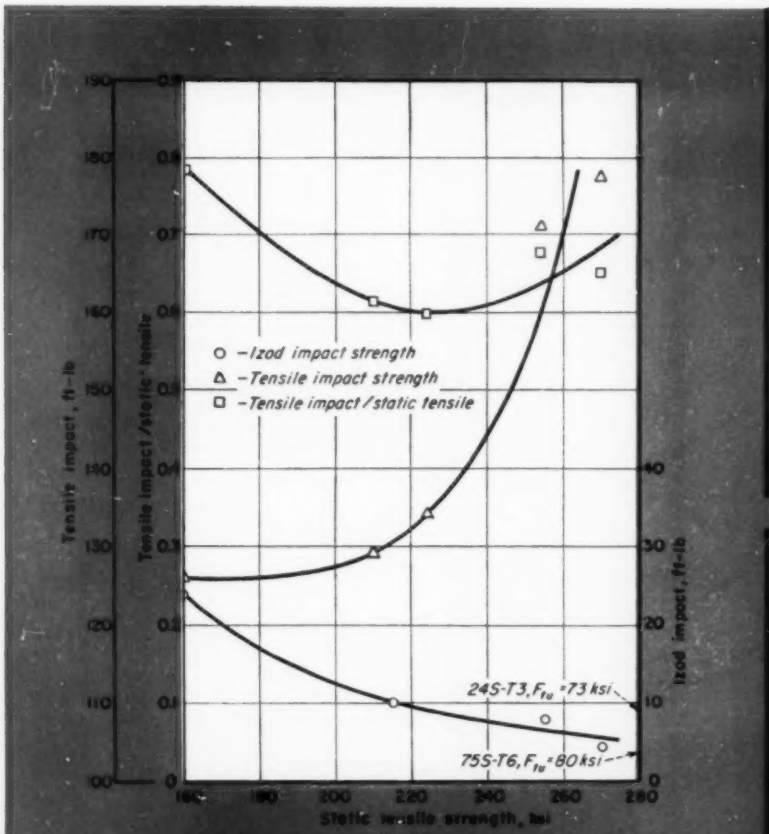

Tensile impact, ft-lb
Tensile impact/static tensile
Izod impact, ft-lb
Static tensile strength, ksi
O – Izod impact strength
Δ – Tensile impact strength
□ – Tensile impact/static tensile
24S-T3, F_{tu} = 73 ksi
75S-T6, F_{tu} = 80 ksi

Fig. 11—Tensile and Izod impact strength at various static strength levels for SAE 4340 steel.

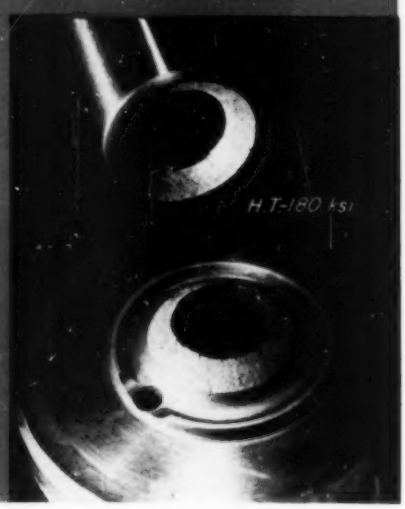


Fig. 12—Damper pistons tested under impact at room temperature. No brittleness was evident.

the tension impact strength increases with increasing static tension strength in the range of static strengths tested.

A more rational way of comparing tensile impact strength at various strength levels is to consider the variation of the ratio of tensile impact to static tensile strength. This ratio is also shown in Fig. 11 where the impact-to-static tension strength ratio at 260-280 ksi is approximately the same as at the 180-200 ksi level. For whatever it may mean, the Izod impact data in Fig. 11 indicates that this property decreases with increasing tensile strength. The Izod strength at the 260-280 ksi level, however, is in the same range as 24S-T3 and 75S-T6 aluminum alloys, materials which have given satisfactory service experience.

In addition to the standard impact specimens, tests on pieces simulating an actual production part were conducted in a drop tower. These specimens have a static strength of approximately 479,000 lb in the 260-280 ksi heat treat range.

The tests consisted of dropping an 800-lb hammer from a maximum height of 21 ft so that the kinetic energy was transmitted uniformly to the piston head of a specimen closely simulating a standard airplane drag strut damper piston. Strain gages were installed on the piston shank to measure the reacting load. Specimens were tested at ambient temperature and also at —70 F for both the 180-200 and 260-280 ksi heat treat levels. Testing was accomplished by repeatedly dropping the hammer from increasingly higher levels until failure occurred. No evidence of brittleness was noted in any of the failed areas following either the ambient or the sub-zero temperature impact tests. Test results showed that pistons heat treated to 260-280 ksi develop impact strengths which compare favorably with lower-heat-treat pistons at both ambient and sub-zero temperatures. Fig. 12 shows failed specimens of 180-200 and 260-280 ksi heat-treated material.

Tensile impact tests of ASTM Type V—0.25 in. dia and 1.0 in. gage length—were also conducted for the 180-200 and 260-280 ksi heat treat levels at both 70 and —70 F. These tests indicate that the tensile impact strength at strength at 260-280 ksi is higher than that at 180-200 ksi and also that the slight reduction which accompanies a lowering of the testing temperature from 70 F to —70 F is less for the 260-280 ksi material than for the 180-200 ksi specimens.

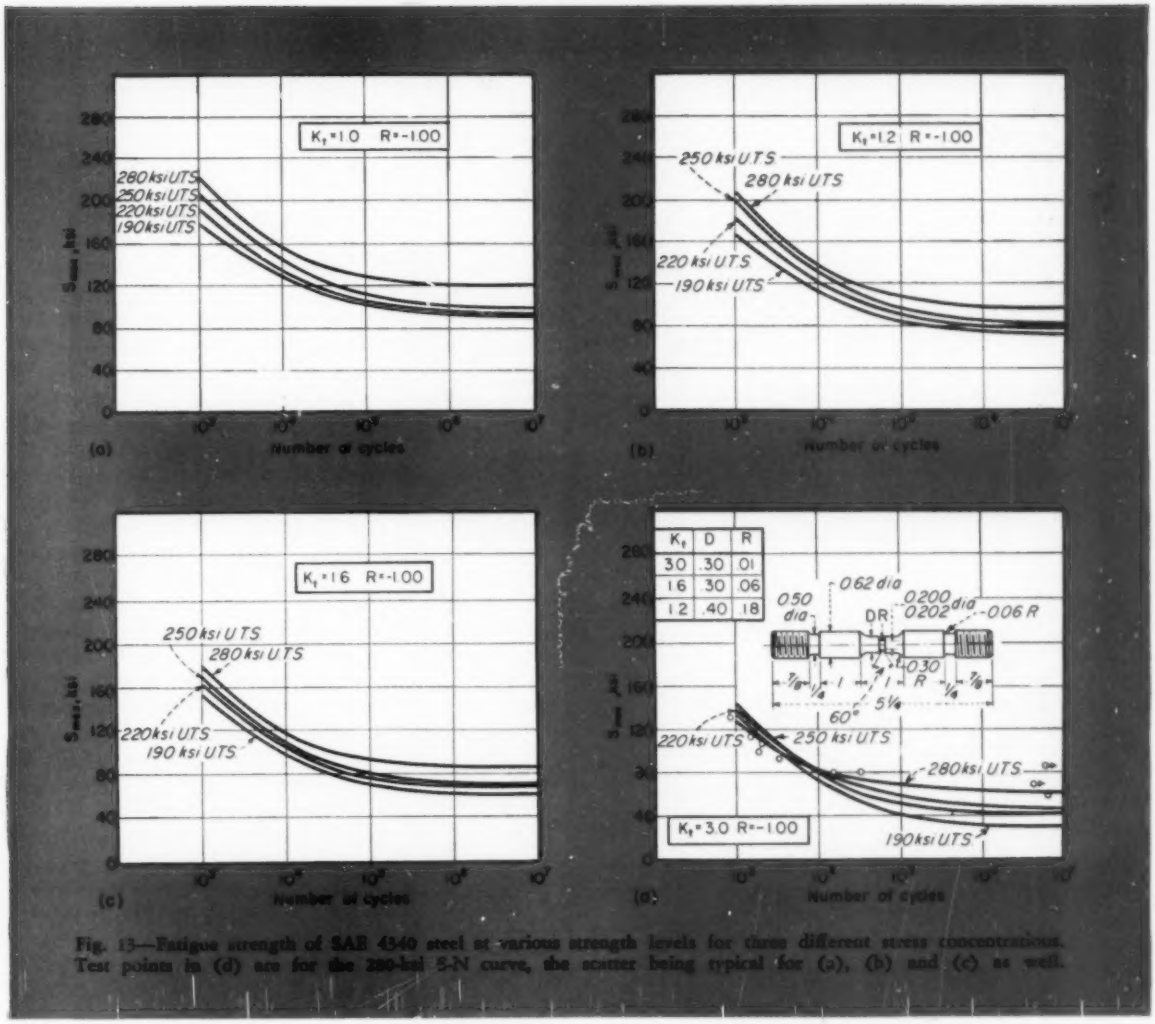
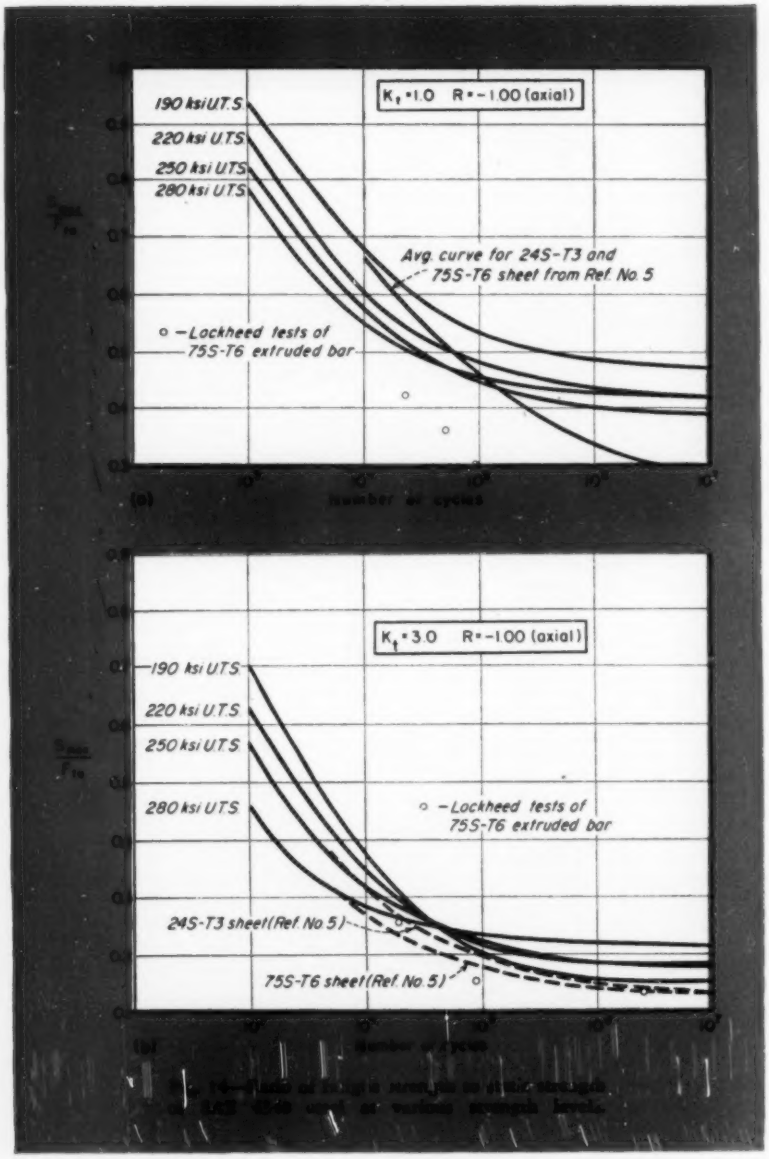


Fig. 13—Fatigue strength of SAE 4340 steel at various strength levels for three different stress concentrations. Test points in (d) are for the 280-ksi S-N curve, the scatter being typical for (a), (b) and (c) as well.

FATIGUE PROPERTIES

One of the major prejudices against the use of steels at high strength levels has been the general belief that the notched fatigue strength does not increase with static tensile strength beyond the 200-ksi static strength level. This is an important consideration because it is the static strength that governs the design of aircraft landing gears and other structural components. Hence, if an increase in strength level is accompanied by a decrease in the ratio of fatigue to static strength in the critical fatigue condition, a part made from the high-strength material would have a shorter life than one made from lower-strength material (the ultimate strengths and detail designs of the two parts being equivalent). From a life standpoint, a most desirable situation would exist if the ratio of fatigue strength to ultimate tensile strength remained either constant or increased with increasing tensile strength. If this were the case, parts made from high strength material would have a life as long or longer than parts made from lower strength material. Fatigue tests conducted at Lockheed indicate that even though this ideal situation is not completely realized, it is closely approximated throughout a wide range of the fatigue curves which have some practical significance for evaluating the life of aircraft components.

The details of these fatigue tests are as follows: S-N curves were established under completely reversed axial loading ($R = -1$) for SAE 4340 steel at various strength levels ranging from 190 to 280 ksi. Sets of these curves, Fig. 13, were established using test specimens having stress concentration factors, K_t, of 1.2, 1.6 and 3.0 at each strength level. These specimens are illustrated in Fig. 13(d) which includes test points for the 280-ksi curve. The scatter of these points is typical for the other S-N curves. In addition, a few check points were obtained using the more realistic (but less severe) condition wherein the applied stress varies from zero to maximum tension ($R = 0$) at each strength level and for each stress concentrator intensity. These S-N curves show that the notched fatigue strength increases with increasing static tensile strength throughout the entire range covered, except for the low cycle range of the $K_t = 3.0$ curve where the fatigue strength remains substantially constant as the


K_t = 1.0 R = -1.00 (axial)
190 ksi U.T.S.
220 ksi U.T.S.
250 ksi U.T.S.
280 ksi U.T.S.
Avg. curve for 24S-T3 and 75S-T6 sheet from Ref. No. 5
o — Lockheed tests of 75S-T6 extruded bar
(a)
K_t = 3.0 R = -1.00 (axial)
190 ksi U.T.S.
220 ksi U.T.S.
250 ksi U.T.S.
280 ksi U.T.S.
o — Lockheed tests of 75S-T6 extruded bar
24S-T3 sheet (Ref. No. 5)
75S-T6 sheet (Ref. No. 5)
(b)

static strength increases. Referring to Fig. 13 for stress concentration factors of 1.0, 1.2 and 1.6 and beyond 10^4 cycles for a stress concentration factor of 3.0, there is a definite increase in fatigue strength with increasing static strength throughout the range from $F_{tu} = 190$ ksi to $F_{tu} = 280$ ksi, inclusive.

To interpret these fatigue data in terms of design conditions, it is helpful to compare the fatigue strength of the high strength steel with steel at lower strength levels and with other materials known to have satisfactory fatigue life in actual service. Since aircraft structural elements are usually designed on the basis of static strength, this comparison can be best made by expressing the fatigue data in terms of ultimate static strength. In Fig. 14, which represents replots of data in Fig. 13, the ratios of maximum applied stress to static ultimate tensile stress are plotted against the numbers of cycles to failure. Thus, the fatigue properties are presented in non-dimensional form and the comparison between the various strength levels can be made directly from the curves. The plots in Fig. 14(a), which are based on polished specimens, are only of academic interest because service failures occur at points of stress concentration.

Experience has shown that a stress concentration factor of $K_t = 3.0$ is typical of aircraft landing gear structural elements as presently fabricated. Consequently, the curves in Fig. 14(b) are representative of landing gear parts.

Examination of these curves reveals that, after about fifty thousand cycles, the fatigue-to-static strength ratio for 260-280 ksi material is greater than for lower heat treat steels. Experience indicates that in-service fatigue failures are usually the result of relatively low stress applied a great number of times. For loadings such as these, the fatigue life of parts made from 260-280 ksi heat treat steel should be as long or longer than for parts made of lower heat treat material.

Below fifty thousand cycles, the ratio of fatigue strength to ultimate tensile strength is lower for the 260-280 ksi material than for steels at lower heat treats. This fact cannot be ignored. Recent studies of the load spectrum to which landing gears are subjected indicate there are certain types of heavy loads applied a relatively small number of times that contribute appreciably to the fatigue damage of the gear. These loads occur in the portion of the fatigue curve, Fig. 14(b), where the high heat treat material appears to be inferior to materials at lower heat treat. The comparison curves for 75S-T6 and 24S-T3, Fig. 14(b), fall below the 280-ksi steel curve beyond 5,000 and 7,000 cycles, respectively. Hence, in a major portion of the low-cycles range, 280-ksi steel with a fatigue-to-static strength ratio poorer than those for lower heat treat steels, is superior to the aluminum alloys that have given satisfactory service in landing gear components and attachment points.

The effect of stress concentration factor on fatigue characteristics of both SAE 4340 heat treated to 280 ksi and 75S-T6 aluminum alloy is shown in Fig. 15. For the range of stress concentrators typical of aircraft landing gears, the fatigue properties of high heat treat steel are about equivalent to those of 75S-T6 aluminum alloy in the low-cycle range (5,000 cycles) and appreciably better than 75S-T6 in the high-cycle range.

These facts notwithstanding, the loss of relative fatigue strength of high heat treat steel compared to lower heat treat material in the low cycle range may present a problem under some conditions. If major fatigue damage is produced by low cycle loading and fatigue life is only marginal when the lower heat treat steels are used, then added precautions may be required in design to assure adequate life for parts made from high heat treat material. This presents no insurmountable difficulty since fatigue life can be appreciably increased by exercising greater care in detail design, by shot peening in areas of stress concentration or by using reduced allowables in areas of stress concentration.

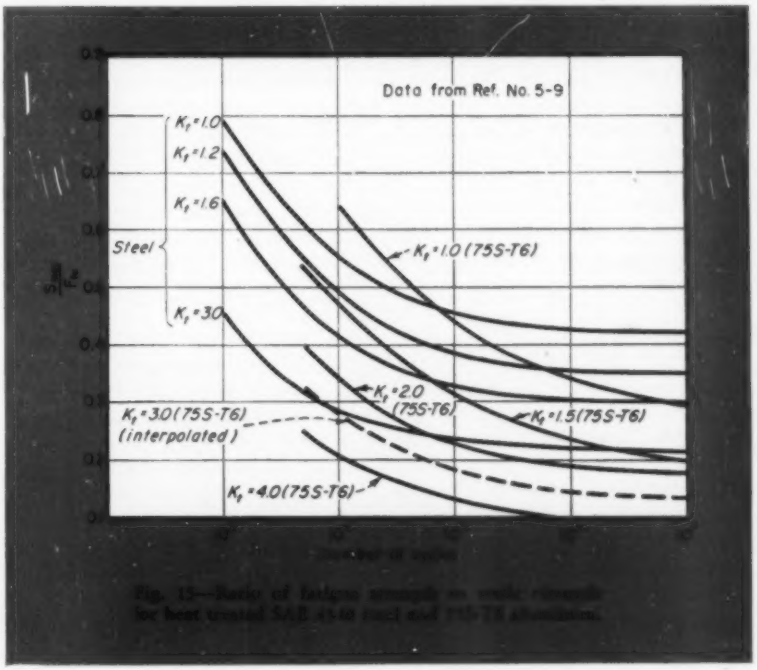
In addition to obtaining the basic material data outlined above, Lockheed conducted fatigue tests on simulated production parts to verify the test results obtained with test bars. For this phase of the investigation, a standard main landing gear drag strut damper piston was chosen because this part was also used in evaluating impact properties. Previous tests on the drag strut damper piston heat treated to 180-200 ksi had shown that, as originally designed, this part was prone to fatigue failure in the radius under the piston head. These early tests had also shown that increasing the radius under the piston head and shot peening greatly improved the fatigue strength. Since fatigue data were available at the 180-200 ksi level for the damper piston, this part was ideally suited to determine the effects of increased static strength.

To obtain comparative data, fatigue tests on high heat treat damper pistons were conducted. The specimens used closely simulated the damper piston previously tested and the loading schedule was based on the earlier test at the 180-200 ksi heat treat level. Applied loads, however, were increased by the ratio 260/180 in order to simulate the operating stress level which would have existed had the part originally been designed at the 260-280 ksi static strength level. Seven specimens were tested: two standard specimens that were duplicates of the original piston and five reworked specimens having the larger shot peened radius under the piston head which the tests at the 180-200 ksi level had shown would result in an increase in fatigue strength.

The results of the fatigue tests of both the standard and the reworked specimens at the 260-280 ksi strength level compared favorably with the tests of actual parts at the 180-200 ksi strength level. However, an unusual secondary effect was discovered during tests on the high heat treat specimens when failure of two reworked specimens occurred in the straight section of the shank where the area was 26 percent greater than at the shoulder radius. The other two reworked specimens failed at the bore radius. All of the failures that occurred in areas other than the shoulder radius originated at the as-heat-treated inner surface of the damper piston shank. In the case of the reworked specimens heat treated to 260-280 ksi, the stress concentration at the shoulder was a less critical factor than either the radius at the bottom of the shank bore or the condition of the inner surface of the shank. Study of the two specimens, which failed at the bore radius and of one from the lower heat treat group which had also failed at this point, indicated that the effective elastic stress concentration factor for these specimens was approximately 3.6. It was therefore concluded that the effective elastic stress concentration factor for the as-heat-treated inner surface of the specimens, which failed in the straight section of the shank, must also have been in the order of three to four.

To check the stress concentration effect of the as-heat-treated surface, additional fatigue tests were conducted using steel bars heat treated to 180-200 and 260-280 ksi. Also, fatigue tests of bars that had been shot peened were conducted at both static strength levels. These tests indicated that, whereas the as-heat-treated surface caused only a moderate reduction in fatigue strength at the 180-200 ksi level, the as-heat-treated surface of the 260-280 ksi specimens resulted in a greater reduction in fatigue strength in the high cycle region than a notch having a geometrical stress concentration factor of approximately four. Furthermore, these tests showed that shot peening improved the fatigue strength of the as-heat-treated surfaces to values approximating the unnotched fatigue strength of the parent material.

No definite explanation is offered for the very large relative reduction in fatigue strength caused by the as-heat-treated surfaces of the high heat treat material. Indications are, however, that the combined effects of decarburization and surface scale on the as-heat-treated surfaces is far more serious in the case of material heat treated to 260-280 ksi than in the case of ma-



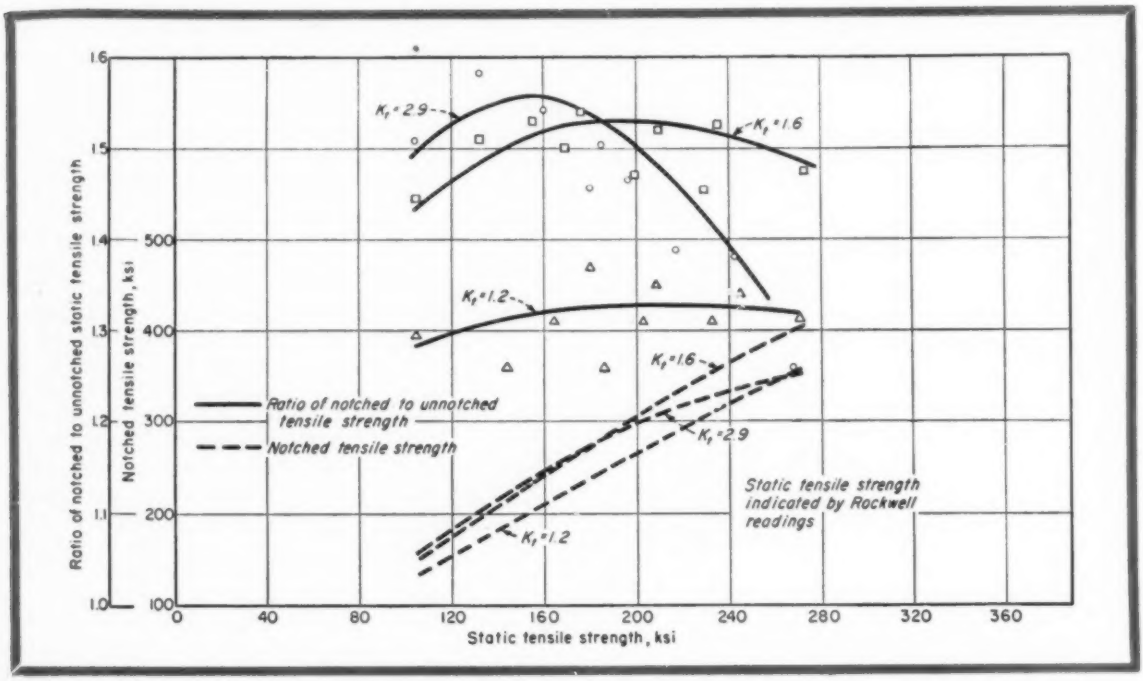

Ratio of notched to unnotched static tensile strength
Notched tensile strength, ksi
Static tensile strength, ksi
K_t=2.9
K_t=1.6
K_t=1.2
Ratio of notched to unnotched tensile strength
Notched tensile strength
Static tensile strength indicated by Rockwell readings

Fig. 16—Notch sensitivity of SAE 4340 steel at various strength levels.

terial at the 180-200 ksi level. Irrespective of the mechanics of the reduction in fatigue strength, the deleterious effects of the as-heat-treated surfaces are substantially removed by shot peening. Since even the best heat treating techniques cannot produce parts that are consistently free of decarburization, it is necessary to take special precautions on parts or areas of parts heat treated to 260-280 ksi which are critical in fatigue. Such parts should be final machined after heat treatment or, where this is not possible, they should be shot peened after heat treatment. In any event, it is advisable to limit the amount of decarburization on parts heat treated after final machining to a maximum of 0.003 inch.

NOTCH SENSITIVITY

As discussed above, fatigue strength as such is difficult to interpret in terms of practical design considerations because of the indefinite nature of service load distributions. However, the ratio of notched to unnotched strength, or notch sensitivity is an excellent index of the toughness characteristics of a material under any type of loading.

In evaluating SAE 4340 steel at the 260-280 ksi static strength level, notched specimens having several different notch intensities (elastic stress concentration factors) were tested under static, impact and fatigue loads. In no case was an excessively high sensitivity to notches found to exist and, in the fatigue tests, a definite reduction in notch sensitivity was found to accompany increasing static tensile strength. This reduction can be attributed, at least partially, to the reduction in yield-to-ultimate strength ratio at the higher strength level. Because the ratio of yield to ultimate stress is smaller at the higher strength level, the operating stresses occur at a higher percentage of the yield stress. Thus, plastic alleviation is more effective at the higher strength level, and the notch effect is reduced by this plastic deformation.

To evaluate the static notch sensitivity of SAE 4340 steel at the 260-280 ksi strength level, notched static test specimens having elastic stress concentrators of 1.2, 1.6 and 2.9 were tested at each of ten different static strength levels. Fig. 16 shows curves for the ratio of notched to unnotched static tensile strength plotted against static strength. In these curves, the basic material strength was obtained by Rockwell hardness readings and the values of elastic stress concentration factor and ultimate notched tensile stress were based on the net area of the root of the notch. The minimum ratio of net area failure stress to material strength is 1.2, indicating that, with the stress concentrator approximately equal to 3.0, the net area notched tensile strength is 20 percent greater than the unnotched material strength. Thus, it appears that the static notch sensitivity, although

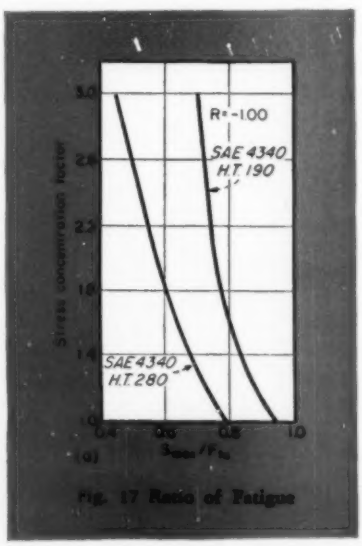


Fig. 17 Ratio of Fatigue

slightly greater at 260-280 ksi heat treat than at 180-200 ksi heat treat, is entirely satisfactory for aircraft design.

The curves in Fig. 17 are the ratios of fatigue to static strength for various stress concentrator intensities at two different heat treat levels. For purposes of comparison, similar data for 24S-T3 and 75S-T6 materials are included in Fig. 17 (b), (c) and (d).[5-9] Except for the very low cycle range of Fig. 17 (a) there is a noticeable decrease in notch sensitivity with increasing strength level from 190-to 280 ksi. Also, in Fig. 17 (b), (c) and (d), for the 10^7 and 10^5 ranges and for a stress concentrator equal to or greater than 1.6 in the 10^4 range, the notch sensitivity of steel at the 260-280 ksi strength level is equal to or less than that of the high strength aluminum alloys.

FABRICATION and PROCESSING

Concurrent with the structural tests of high heat treat steel, investigations were conducted to establish the production characteristics of this material. Machinability, weldability, heat treatment, effects of finishing procedures, and other production factors were investigated not only to insure that no adverse effects were produced by fabrication and processing procedures, but also to determine whether high heat treat parts could be produced efficiently and economically.

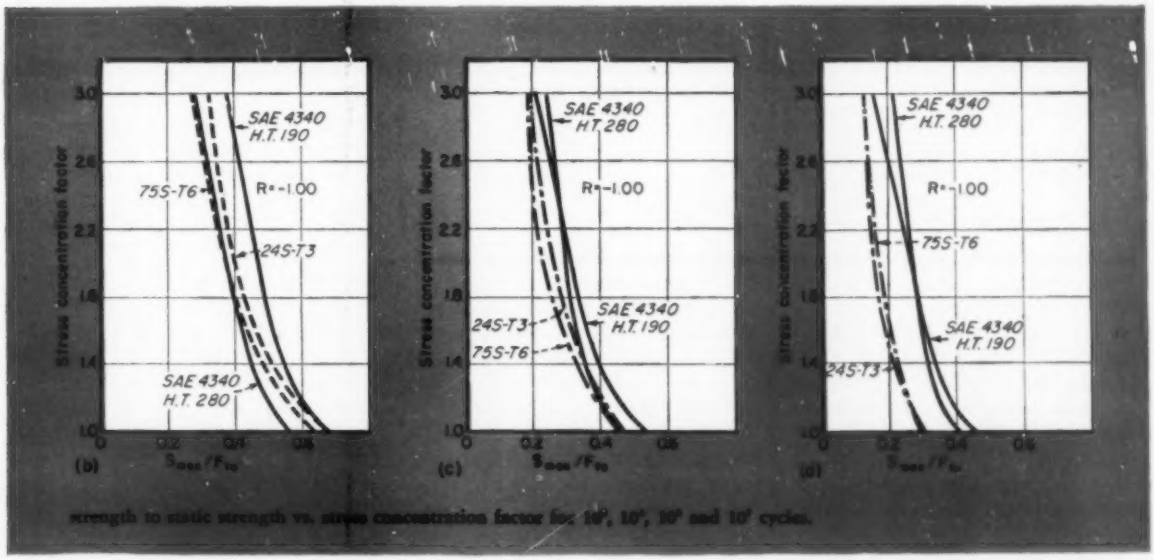
In general, there are no serious production problems. Machinability is excellent and, although special techniques are used in most machining operations, steel parts can often be machined at the 260-280 ksi hardness level more rapidly than has been normal practice at lower heat treat levels. Weldability appears to be satisfactory insofar as flash and pressure welding are concerned. Preliminary test indicate that satisfactory fusion welds can be made using commercially available electrodes and rods. As mentioned above, heat treatment appeared at first to be critical. However, this problem was solved by using a heat treat schedule wherein the tempering temperature is a function of the as-quenched hardness of the particular batch of material being treated. The resultant hardness range is as consistent as, and probably even more consistent than, the hardness range obtained at lower strength levels.

One factor which appeared to be serious during the early stages of the investigation was the occurrence of cracks in ground surfaces. Since the grinding process involves severe localized temperature differentials, it was to be expected that a certain percentage of rejections would be caused by so-called grinding checks. It was discovered, however, not only that an excessive number of specimens were rejected because of cracks formed during grinding, but also that parts which had not cracked during the grinding process were apt to crack during subsequent processing operations.

This was particularly true when subsequent operations included sources of hydrogen embrittlement as is the case in cleaning, pickling and plating. To a lesser extent, it was found that some parts which had not been ground were cracking during certain processes known to cause hydrogen embrittlement. These cracks were attributed to residual stresses developed during grinding or quenching combined with hydrogen embrittlement.

To determine the source of the embrittlement effect and to verify that baking would effectively erase that effect, tests were made of parts which had been subjected to various combinations of machining, grinding, cleaning, plating and baking operations. Since embrittlement cannot be detected to any degree of reliability by elongation measurement, and since the measurement of reduction in area is a tedious process, the test specimen shown in Fig. 18 was devised for this series of tests. The stress concentration factor at the juncture of the head and the shank is high for this specimen—in the order of 10 or greater—and consequently embrittlement is indicated by a sharp drop in static tensile strength when the specimen is tested under axial load.

These tests are summarized in Table III. Although there seems to be no appreciable change in strength for the specimens which were baked after plating, or for those which were not plated, irrespective of the sequence of produc-



strength to static strength vs. stress concentration factor for 10^8, 10^6, 10^4 and 10^2 cycles.

Table III—Embrittlement Study
(For Specimen Geometry, see Fig. 18)

Specimen Preparation (after heat treatment)	Ultimate Tensile Strength, ksi (average for 3 specimens)	
	H. T. to 200–220 ksi	H. T. to 260–280 ksi
Machined only	233.3	272.4
Machined, baked at 375 F for 3 hr[4]	223.7	271.3
Machined, baked 6 hr (200–220) and 11 hr (260–280)	223.1	272.9
Machined, cad. plated	95.2[3]	92.2[3]
Machined, cad. plated, baked 3 hr (200–220) and 8 hr (260–280)[5]	221.8	268.6[1]
Ground only[6]	222.9	273.0
Ground, baked, cad. plated	109.8[3]	97.0[3]
Ground, cad. plated, baked[5]	221.7	268.5
Ground, baked 3 hr, cad. plated, baked immediately[5]	221.7	266.5[2]
Ground, baked 3 hr, cad. plated, held 3 hr, baked[5]	223.9	265.6
Ground, baked, cad. plated, held 8 hr, baked[5]	222.1	269.7
Ground, baked, chrome plated, held 3 hr, baked[5]	221.8	263.1[3]
Ground, peened, cad. plated, baked immediately[5]	220.6	270.3
Ground, peened, cad. plated, held 3 hr, baked[5]	219.7	267.1
Ground, peened, cad. plated, held 8 hr, baked[5]	220.7	262.2[1]
Ground, peened, chrome plated, held 3 hr, baked[5]	208.5[1]	262.6[2]
Ground, baked, peened, cad. plated, baked immediately[5]	221.6	270.2
Ground, baked, peened, cad. plated, held 3 hr, baked[5]	222.6	269.5
Ground, baked, peened, cad. plated, held 8 hr, baked[5]	221.6	267.8
Ground, baked, peened, chrome plated, held 3 hr, baked[5]	219.8	264.2[2]
Machined, baked 8 hr	.....	269.9

[1], [2], [3] Number of specimens which failed in area of high stress concentration beneath head. All others failed in reduced section of shank with typical ductile failure.
[4] All baking operations performed at 375 F.
[5] All baking after plating performed at 375 F for 3 hr with 200–220 ksi specimens and 8 hr with 260–280 ksi specimens.
[6] Grinding performed only in areas to be plated.

tion operations, two facts are clearly illustrated by the test data: (1) There is a sharp drop of about 60 percent in the tensile strength of all specimens which were plated but not baked after plating; and (2) baking at 375 F after plating brings the tensile strength up to substantially that of the unplated material.

Another observation made during examination of the failed specimens is that all of the specimens which had been plated, but not subsequently baked, failed in a brittle manner at the point of high stress concentration in the relatively sharp radius under the head. The large majority of the remaining specimens, both those which had been baked after plating and those which had not been plated, failed in the specimen shank and exhibited typical ductile failures.

Investigations have been initiated at Lockheed to determine the feasability of welding high heat treat steels by various methods. The preliminary study of the flashwelding process was undertaken to determine whether machine settings previously qualified for lower heat treat levels would consistently produce flashwelds which met specification requirements after being heat treated to the 260-280 ksi range. It was concluded that, although the previously qualified machine settings will not consistently produce welds that comply with specification requirements at the 260-280 ksi strength level, further refinements in machine settings and welding techniques should result in satisfactory flashwelds. Consequently, additional research is currently underway and, to date, flashweld machine settings and welding techniques that will produce welds in full compliance with specification MIL-W-6873 have been established as noted in Table IV for various sizes of tubing.

Pressure welding set-ups that produce satisfactory welds at the 260-280 ksi strength level have been established for tubing as listed in Table V. This test work was conducted at the Menasco Manufacturing Company.

Some experimenting has been done to establish the strength of fusion welds. Commercially available electrodes and rods have been used in conjunction with the arc, inert-arc and gas welding processes. These tests show that by using a P & H -21 welding electrode, an average tension joint efficiency of 87 percent can be achieved at the 260-280 ksi level. The average elongation in 2 in. for this electrode was 2.1 percent while the free bend test showed an elongation of 12.5 percent. Metallographic, radiographic and magnetic examinations of specimens welded with P & H -21 electrodes were entirely satisfactory.

As a result of the investigations on fabricating and processing of material heat treated to 260-280 ksi, Lockheed has adopted practices which in certain instances are different from those used to produce parts at lower strength levels. The following is a brief summary:

(1) Heat treatment should be performed in a controlled-atmosphere furnace unless a minimum of 0.020 in.

of material is removed after treatment.

(2) Tempering temperature should be determined either by as-quenched hardness reading or from the Jominy hardenability of steel being treated.

(3) Parts should be normalized prior to heat treatment.

(4) All parts should receive a retained austenite stabilization treatment consisting of a 24-hr bake at 250 F after all other heating operations above this temperature.

(5) Wherever possible, parts should be final machined after heat treatment.

(6) If parts are heat treated after final machining and if fatigue is a consideration, parts should be shot peened.

(7) Avoid grinding when possible.

(8) If parts are ground at the 260-280 ksi level, they should be baked at 375 F for four hours and then shot peened.

(9) Parts which are cold straightened after final heat treat should be baked at 375 F for four hours and shot peened in the area of the straightening.

(10) Parts that are electroplated, pickled, electrolitically cleaned or given phosphite type cleaning should be baked at 375 F; electroplating for eight hours, the others for four hours.

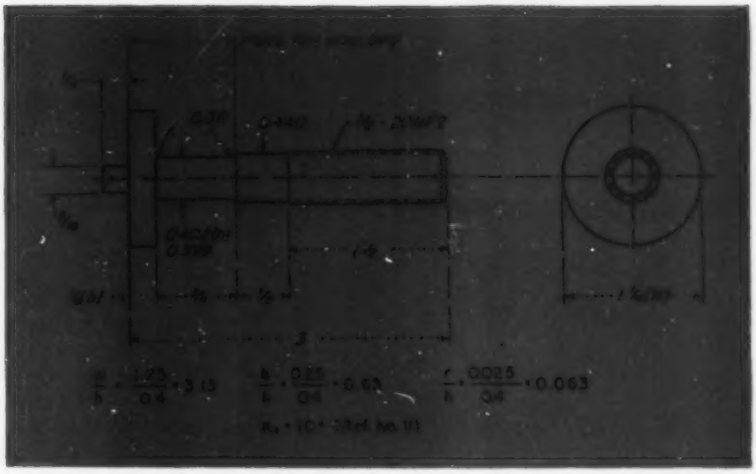


Fig. 18—Static tension specimen for showing effects of hydrogen embrittlement.

Acknowledgements—The findings presented in this article are the results of the collective effort of many groups and individuals within the Lockheed Aircraft Corporation Engineering Department. In particular, the author wishes to acknowledge the work of various people in the Engineering Research Laboratory, Production Engineering Department, and Structures Division whose contributions and assistance have made the article possible.

Table IV—Static Tensile Strength of Flashwelds Heat Treated to 260–280 ksi

Tube Size, in.		Area, in.²	Specimens Tested	Base Metal Failures	Av Base Metal Failure, psi	Weld Failures	Av Weld Failure, psi
O.D.	Thick						
3.00	0.130	1.172	23	19	286,127	4	280,242
2.00	0.188	1.070	20	13	271,611	7	269,280
1.75	0.120	0.615	27	27	280,319	0	——

Table V—Static Tensile Strength of Pressure Welds Heat Treated to 260-280 ksi

Tube Size, in.		Specimens Tested*	Base Metal Failures	Av Base Metal Failure, psi	Weld Failures	Av Weld Failure, psi
O.D.	Thick					
3.25	0.250	15	13	260,461	2	270,500
4.25	0.346	63	63	274,492	0	——
6.25	0.460	49	24	264,042	25	262,240

* Each sample weld cut into eight strip test specimens.

REFERENCES

(1) "New Steel Features High Strength and High Ductility," Peter Payson and A. E. Nehrenberg, *The Iron Age*, October 21 & 28, 1948.

(2) "Bending Strength in the Plastic Range," F. P. Cozzone, *Journal of the Aeronautical Sciences*, May 1943.

(3) "Strength of Metal Aircraft Elements," ANC-5 Bulletin, Revised Edition, June 1951.

(4) "Investigation of the Mechanical Properties and Physical Metallurgy of Aircraft Alloys at Very Low Temperatures," Air Force Technical Report 5662.

(5) "Fatigue Strength of Aircraft Material With Stress Concentration Factors of 2.0 and 4.0," NACA TN 2389.

(6) "Fatigue Strength of Aircraft Material," NACA TN 2324.

(7) "Fatigue Strength of Aircraft Materials With Stress Concentration Factor of 5.0," NACA TN 2390.

(8) "Fatigue Strength of Aircraft Materials With Stress Concentration Factor of 1.5," NACA TN 2639.

(9) "Summary of Fatigue Tests of 14S, 24S, and 75S Aluminum Alloys in the Form of Rod, Plate, Forgings and Extrusions," Alcoa Report 9-49-1, January 12, 1949.

(10) "The Mechanical Properties of Quenched and Tempered Medium Carbon Steels," P. S. Kennedy, J. W. Lodge and G. K. Manning, Battelle Progress Report, July 1952.

(11) "Some Applications of Photoelasticity in Turbine-Generator Design," M. Hetenyi, ASME Transactions, *Journal of Applied Mechanics*, 1940.

(12) "Preliminary Investigations of the Effects of Low Ductility on Structural Behavior," J. W. Clark, Alcoa Report 12-51-36, November 9, 1951.

(13) "Variations in the Fatigue Properties of 14S, 24S, and 75S Plate, Extrusions and Forgings with Specimen Orientation," R. L. Templin, F. M. Howell, and E. C. Hartman, Aluminum Company of America, February 7, 1950.

SILICONE PUTTY

For Slip Clutches and Couplings

Performance data and design features of new mechanical drives containing this unusual material which is plastic and free-flowing at low stresses, but shatters like glass with large or suddenly applied forces.

MILTON ADLER

SILICONE PUTTY—which got wide spread fame as the "bouncing putty" —is also a useful engineering material. Several applications have already been found, namely: damping media, fluid flow equipment, sealing compounds, and sound transmission devices.

The latest developments are a slip clutch and flexible coupling. The basic principle involved is that the putty will shear under a sudden force but it will also flow together again as soon as this force is relieved. The slip clutch is designed to prevent overload and shocks, for starting heavy loads, absorbing torsional shaft vibrations, and delivering impulse free power. The flexible coupling is intended to compensate for both angular and offset misalignment. The functions of both the slip clutch and the flexible coupling can be combined into one unit.

The construction of the slip clutch, Fig. 1(A), is as follows: A layer of putty separates the serrated faces of the driving and driven shafts. A retainer is threaded to the driven shaft but turns freely on the driving shaft; an annular groove in the retainer traps any putty that may leak initially between the face of the driving shaft and the retainer.

In operation, when the driving shaft starts to rotate, the initial torque shears the putty. Almost instantaneously, however, the silicone flows together and starts to rotate the driven shaft. This process of shearing and reforming continues until both shafts are rotating at the same speed. By adjusting the pressure on the putty, it can be made to shear at any load, above which it will not have sufficient adhesion to drive. At the same time, the silicone will absorb torsional vibrations.

The construction of the flexible coupling Fig. 1(B), is basically the same as that of the slip clutch, except that the retainer has a spherical internal seat upon which rests a spherical spacer. A large clearance is provided between the driving shaft and the opening in the retainer. This allows the shaft and spacer to move angularly relative to the retainer and allows the shaft to slide on the spacer while remaining parallel to the driven shaft.

The operation of the flexible coupling is also similar to that of the slip clutch. However, means are provided to compensate for angular and axial misalignment; the driven shaft and the spacer can move to compensate for the misalignment by displacing the soft silicone putty.

A typical coupling is shown in Fig. 2. This was assembled with various weights of silicone putty and with different spacings between the serrated

Table I — Silicone Putty Coupling
Variable speed drive—Prony brake test

Coupling assembled one-half turn with 0.25 oz. of putty:

Drive Rpm	Torque In.-Oz.	Torque In.-Lb.	Remarks
300	354	22.1	Putty leaked.
300	522	32.7	Re-assembled. No failure.
1625			Torque applied until motor stopped. No failure.

Coupling assembled one turn with 0.30 oz. of putty:

Drive Rpm	Torque In.-Oz.	Torque In.-Lb.	Remarks
310	162	10.1	Putty leaked.
310	234	14.6	Re-assembled. Failed to drive.
400	210	13.1	Failed to drive.
400	114	7.15	Knitted.
570	306	19.1	Putty leaked.
570	330	20.6	Re-assembled. Putty leaked.
1650	114	7.15	Re-assembled. No failure. Driven speed: 1640 r.p.m.
1650	162	10.1	No failure. Driven speed: 1370 r.p.m.

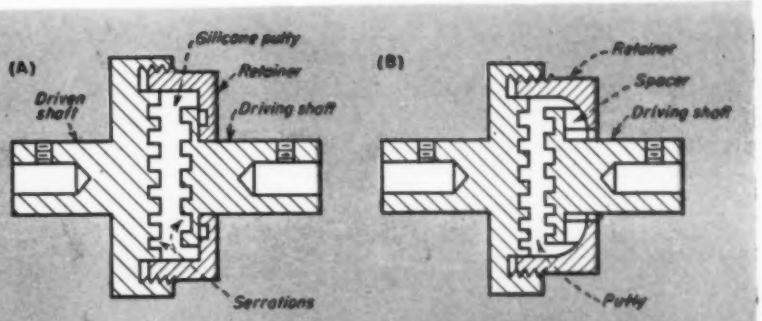


Fig. 1—Slip clutch (A) and flexible coupling (B) have same basic construction. Primary difference is that the retainer for the coupling has a spherical seat that mates with a spherical spacer to provide the required flexibility.

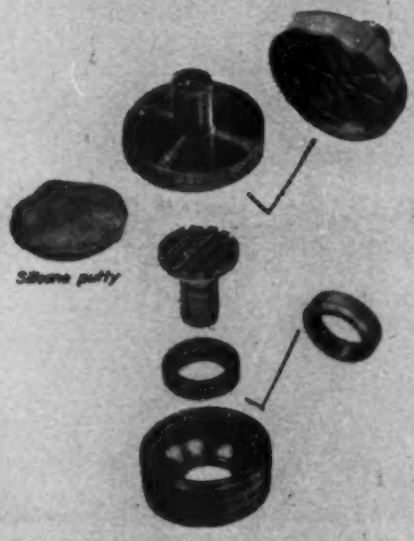


Fig. 2—Typical flexible coupling. Test data are reported in Table I. Fig. 3 shows slip speed-torque data for various lengths of engagement and weights of putty.

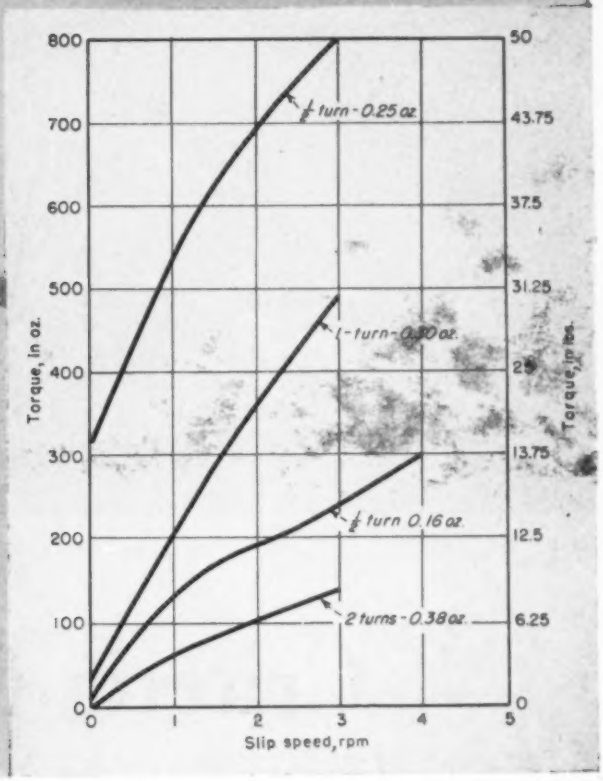


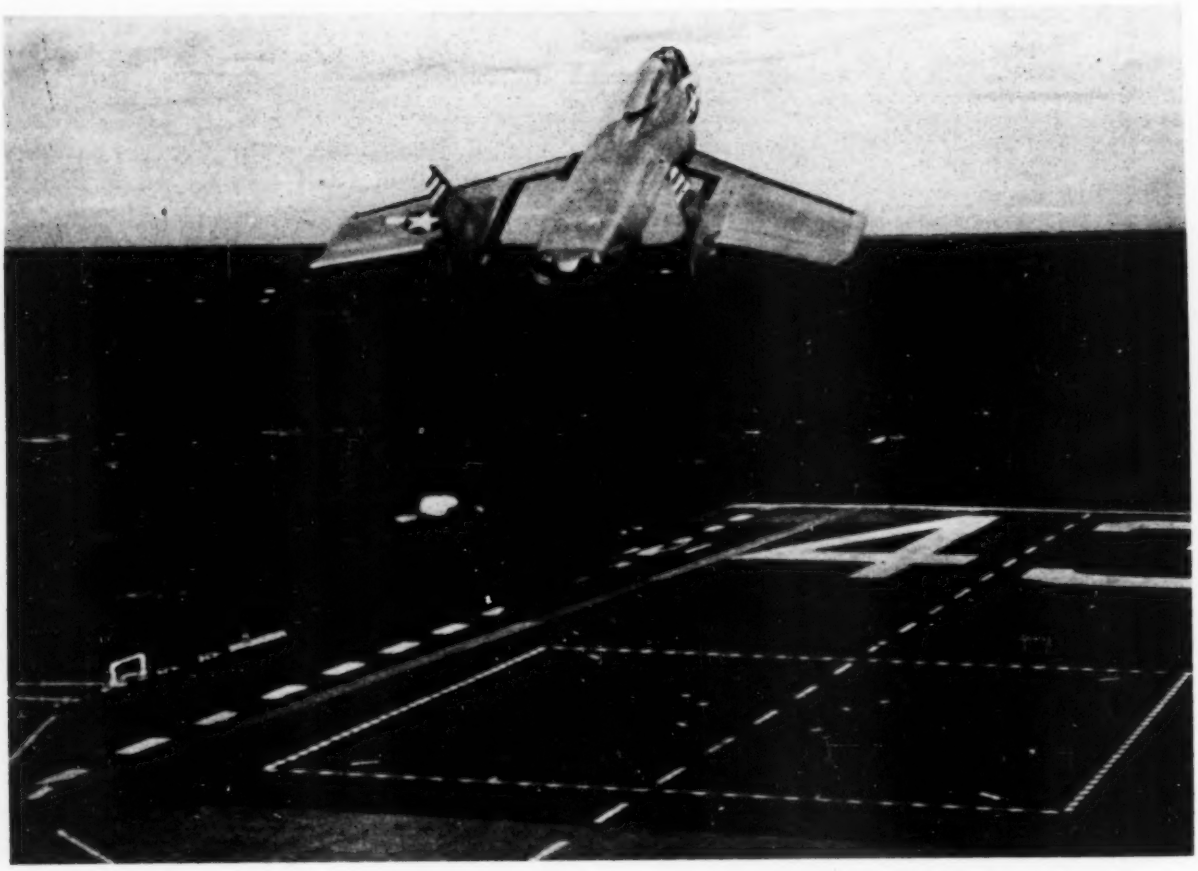
Fig. 3—Low speed test data for flexible coupling. End point of each curve represents maximum developed torque value.

faces. These combinations are shown by weight and number of thread turns from the closed solid condition on the graph in Fig. 3. One test consisted of operating the coupling with one shaft fixed in such a manner that its torque could be measured while the other shaft was rotated at slow speed. This provided data on the driving torque with relation to slip speed, which is given by these curves. The end point of each curve represents the maximum torque developed, the curves remaining essentially flat or dropping off beyond the plotted points.

To get performance data at high speeds, tests were also made driving a prony brake. Torques of approximately half the capacity indicated by Fig. 3 were developed before leakage or complete failure to drive occurred. The results of these tests are shown in Table I. It will be seen that torques corresponding to roughly ¼ hp at 1750 rpm represent the capacity of this coupling.

In addition, the coupling was assembled between a motor and a dynamometer and operated ¼ hp. This was with 0.30 ounces of silicone and one turn opening which was determined to be the best combination from the prony brake tests. After approximately three hours operation, the coupling failed completely and because the motor continued to drive, the silicone deteriorated to such an extent that it would no longer flow together. In addition, it was found that with large amounts of misalignment, the silicone would tend to leak from the coupling.

It was obvious, therefore, that the two critical design problems that can occur are leakage, and the failure of the putty to heal after being sheared at certain speeds. Both problems have now been overcome. It was found that leakage can be eliminated with suitable seals, and the healing of the silicone putty can be controlled by proper design of the serrated faces.



Criteria for Designing

Considerable advancement in the design of lightweight aircraft structures has been made through the use of metal-to-metal bonding. As these structures must have sufficient reserve strength to withstand extreme operating temperatures, joint stresses must be carefully analyzed. The method described herein simplifies this task.

WILLIAM C. BRODING
Chance Vought Aircraft Division
United Aircraft Corporation

CURRENT DEVELOPMENTS in the field of sandwich constructions center around the combination of metal facings bonded to a light-weight core, and the use of bonding for adding elements to increase the stiffness and local strength of sheet metal panels. The increasing application of these bonded constructions to jet aircraft such as the F7U-3 Cutlass necessitated criteria for determining safe design allowable joint strengths, as well as means for evaluating adhesives and controlling their quality in production.

For structural analysis, most joints in a bonded structure can be reduced to an equivalent simple lap joint, Fig. 1(a). At first it would appear that an increase in overlap length, *l*, would give a direct increase in joint strength. But, instead of being constant along the length of the joint, the shear stress varies in the manner shown in Fig. 2(a). The effect of doubling the overlap length, assuming the length for maximum strength has been reached, is shown in Fig. 2(b) where the average stress is half that shown in Fig. 2(a) and the maximum stress is constant. From these characteristics is derived the *stress concentration factor* which is the ratio of the maximum to average stress. If the value of this factor is known and the ultimate shear strength of the bond established, the

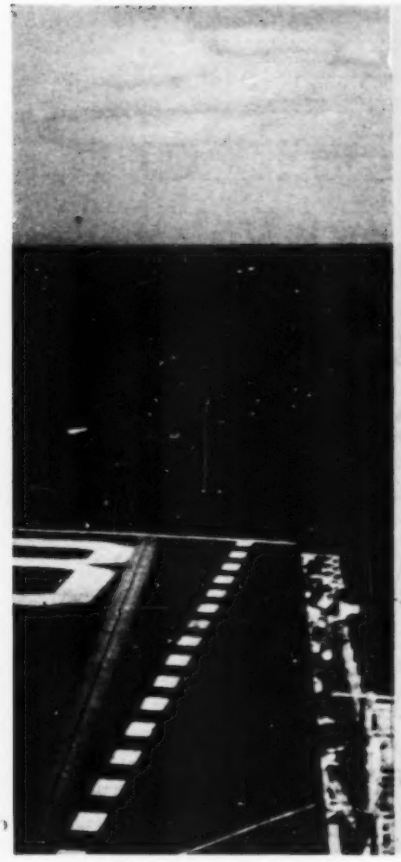
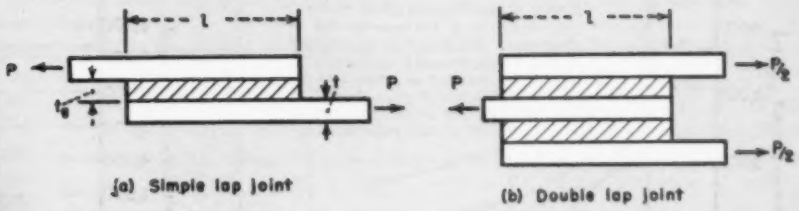


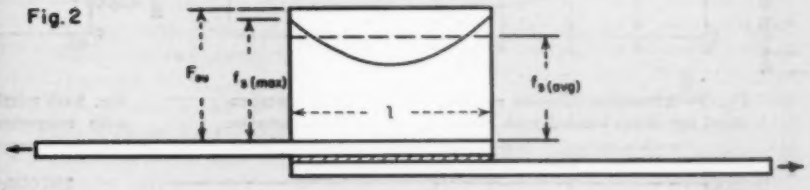
Fig. 1



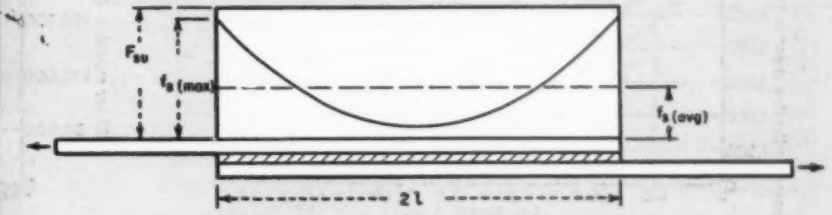
(a) Simple lap joint

(b) Double lap joint

Fig. 2



(a) Shear stress distribution for lap length l



(b) Shear stress distribution for lap length 2l

Adhesive Bonded Joints

strength of the joint can be obtained.

As structural lap joints are usually supported so that the peeling tensile stresses in the bond are small, only shear stresses need be considered. To develop a basic relationship for shear concentrations in a lap joint supported so that it will not bend, consider a joint consisting of two identical metal strips of thickness t, unit width and overlap length l bonded with an adhesive film of thickness t_g. An axial tension load P is applied to the ends of the joint and the bond assumed to deform so that the shearing strain in the bond is constant through the thickness of the bond. By determining the shear strains in the adhesive and metal, the stress concentration factor can be written (Chance Vought Report #7441) as follows:

$$\frac{f_{s(max)}}{f_{s(avg)}} = \frac{1}{K} \coth \frac{1}{K}$$

where

$$\left(\frac{1}{K}\right)^2 = P \frac{G_g}{2 E_{tg}}$$

G_g = Adhesive shear modulus
E = Young's modulus of sheet

The extensional strains in the joint produce tensile stresses in the bond along the length of the joint. When the axial stress is in the elastic range, these stresses have the maximum value

$$\sigma_{bond} = \frac{E_g}{E} \sigma_{sheet}$$

If the metal starts to stretch plastically before the joint fails in shear, these tensile stresses in the adhesive will increase rapidly and may cause the joint to fail. In normal use, however, this tensile stress is sufficiently small to be ignored and the shear strength of the adhesive is considered the criterion of strength.

Noting the equation for stress concentration factor, two types of information must be known when evaluating joint strength: (1) the geometry of the joint expressed by the parameter $l/\sqrt{t}$, and (2) the characteristics of the bond layer expressed by t_g, G_g and $F_s(\max)$. The effect of the variations in joint geometry or adhesive properties on joint behavior can also be

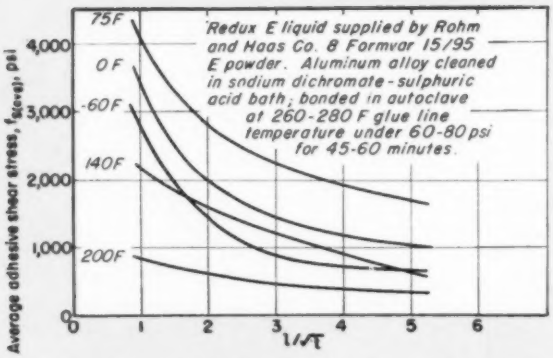


Fig. 3—Allowable adhesive shear stress for 75S-T6 metal-to-metal lap joints bonded with Redux E and loaded in tension.

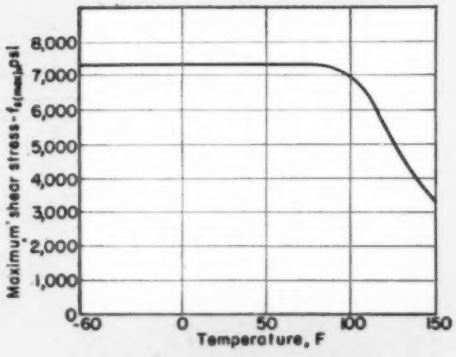


Fig. 5—Variation of maximum shear stress with temperature for Redux E adhesive.

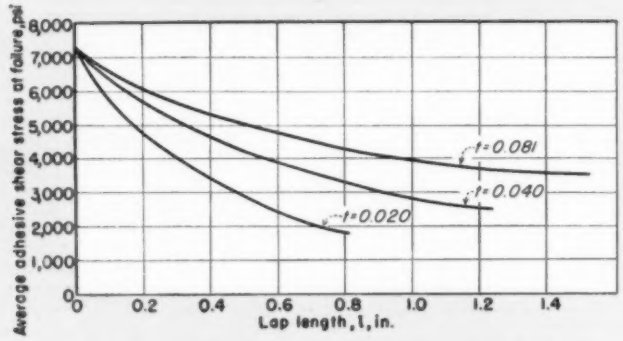


Fig. 4—Variation of adhesive shear stress with lap length for joints bonded with Redux E and tested at room temperature.

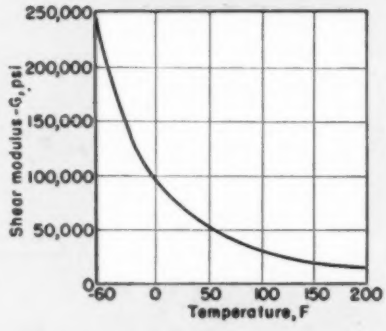


Fig. 6—Variation of shear modulus with temperature for Redux E adhesive.

evaluated from the equation for stress concentration. This equation is based on the fact that an increase in lap length does not necessarily increase joint strength. In addition, it shows that an increase in adhesive rigidity without an accompanying increase in local adhesive shear strength decreases joint strength. This is in accord with the behavior of certain adhesives at low temperatures. Since thickness and rigidity of the bond greatly influence joint strength, a production process assuring uniform bond properties must be established before design strengths can safely be used. Also, it is not possible to make direct comparisons of adhesive strengths when tests are made on lap joints of different geometries, unless the thickness and shear modulus of the bond layer are known.

Occasionally lap joints are loaded in shear, as in the skin splice of a torque box. Stress concentration criteria for joints loaded in tension can be converted to shear conditions by substituting the sheet modulus of rigidity G for the modulus of elasticity E. The following relationship is used for comparing the stresses in joints loaded in shear with those in tension: Adhesive shear stress for joint loaded in shear equals adhesive shear stress for joint loaded in tension times $\sqrt{G/E}$. Values thus obtained will be conservative because the tearing stresses that occur in lap joints tested in tension are not present.

Establishing Design Criteria by Laboratory Tests

In the selection of a standard test specimen for evaluating adhesive strength, structural joints should be approximated. Though a double lap joint, Fig. 1(b), would eliminate bending of the joint, a simple lap joint is specified for experimental evaluation because of its greater usage. A standard specimen consists of two identical strips 1.0 in. wide and 6.0 in. long which are overlapped 1.0 in., bonded according to production methods and tested in tension. Although the joint is unsupported so that the bond is subjected to tearing stresses caused by local bending, the ultimate load carried by the joint is assumed to be pure shear. This conservative assumption is made for the sake of simplicity.

For establishing design strength values, laboratory tests are made in which lap length and sheet thickness are varied and processing details kept constant. A statistical analysis is made of the test data and minimum strength values corresponding to reliability values are computed for each value of $l/\sqrt{t}$. Typical design charts obtained in this manner are shown in Fig. 3 for Redux E adhesive.

If every joint could be reduced to

an equivalent simple lap joint, the curves of Fig. 3 would suffice for design use. However, some joints do not lend themselves to this treatment. In such cases, the expected joint strength can be calculated from an equation similar to the stress concentration equation given above. The maximum allowable shear stress, shear modulus and bond thickness of the adhesive layer must be known. These data can be obtained from tests made to establish the design curves for simple lap joints, with the addition of a measurement for bond thickness in the specimens.

The maximum allowable shear stress could easily be obtained if it were possible to test a lap joint having a uniform distribution of shear stress (lap length approaching zero). A plot of average shear stress versus lap length is therefore made so that the maximum allowable shear stress of the adhesive can be obtained by extrapolation to zero lap length. A reliable value can be obtained by plotting a family of curves for various sheet thicknesses. This group of curves should have a common stress coordinate intercept, which can be determined by fitting curves to the data by the method of least squares. Fig. 4 shows a typical curve obtained by this method, while Fig. 5 gives the results of determinations for maximum shear stress at various temperatures.

In the equation for the stress concentration factor, the factor K can be computed for known values of maximum and average shear stress. If K is plotted versus values of $\sqrt{tt_a/l}$, the value of $\sqrt{G_a/2E}$ can be found by measuring the slope of a straight line that best fits the data by the method of least squares. In this manner, an effective value of adhesive shear modulus is obtained, as typified in Fig. 6. The value of $f_{s(max)}$ and G given in Figs. 5 and 6 can be substituted in the equation for the shear stress concentration factor and design strengths thereby obtained.

Use of Design Curves

Assume that a simple lap joint having the following geometry and loading is to be checked for adequate strength at —60 F: $t = 0.016$ in., $l = 0.6$ in. and $P = 400$ lb per inch of sheet width.

The parameter $l/\sqrt{t}$ is calculated to be 4.75. From Fig. 3, the allowable average bond stress, P, for this joint is approximately 670 psi. The allowable load then becomes 670 × 0.6 or 402 lb per inch, which indicates the joint will safely withstand the required load of 400 lb per inch.

Applications of Bonded Construction

Typical Metalite joints are shown in Fig. 7. The internal doubler on the outer face provides the necessary thickness for countersinking and a similar doubler on the inner face furnishes greater bearing thickness. The external doubler has sufficient material to take large local edge loads such as those along the wing main spar. In determining the strength of a Metalite panel, the strengths of the various local metal-to-metal bonded joints at the panel edge are as important as the strength of the sandwich core.

In the use of magnesium parts for Navy fighter aircraft, corrosive environment is the most important factor. It was found that spotwelded magnesium parts were subject to corrosion because faying surfaces were not protected. The only alternative was to use a method by which doublers, reinforcements and stiffeners have continuous, protected attachment to skin panels and fairings. Adhesive bonding became the answer. Not only are faying surfaces sealed, but cleaner structures result as shown in Fig. 8.

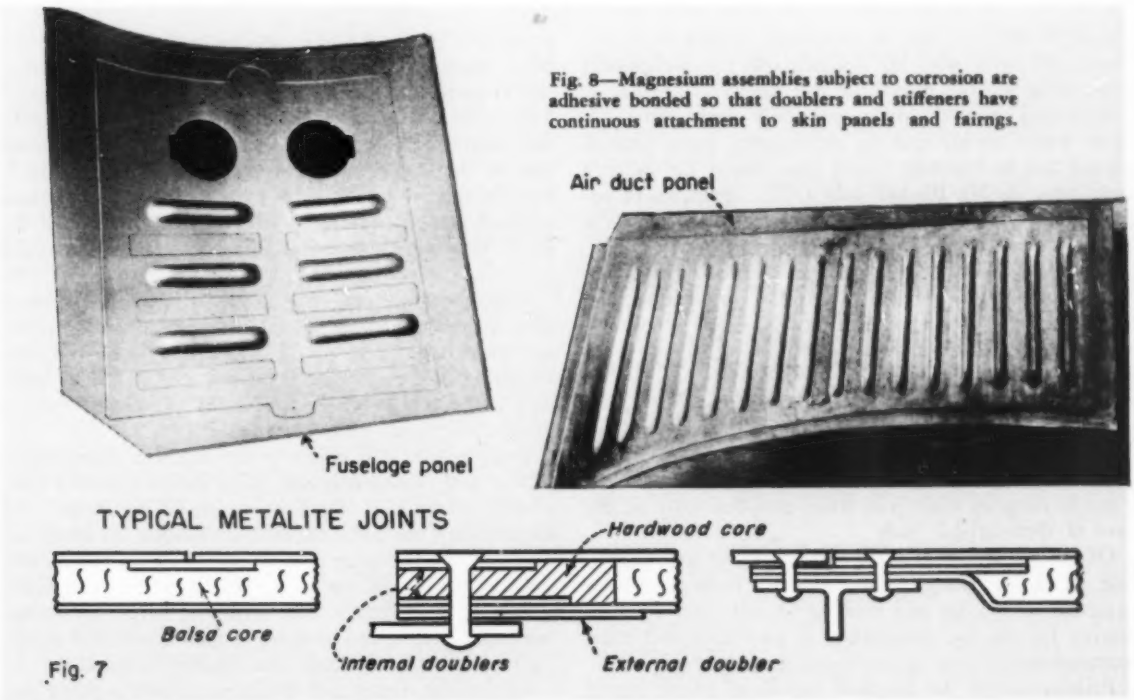


Fig. 8—Magnesium assemblies subject to corrosion are adhesive bonded so that doublers and stiffeners have continuous attachment to skin panels and fairngs.

Fig. 7

Let's Keep Our

EDITOR'S NOTE: In our June editorial, "Smug Engineering Societies," we severely criticized the great national engineering societies for not taking "any position of leadership concerning national affairs that are basically science and engineering and that will have a tremendous effect both upon the profession and the public".

The accompanying editorial by Frederick S. Blackall, Jr., President of the American Society of Mechanical Engineers, appeared in the August number of the publication Mechanical Engineering. It is reprinted herewith by permission. It can be taken as an official answer of the A.S.M.E. to the criticisms presented in the *Product Engineering* editorial mentioned above.

We fully recognize the seriousness of the problem and feel that the correct answer can be arrived at only by an honest presentation of all the facts and opinions.

"FROM TIME TO TIME our Society is taken to task, both publicly and privately, on grounds which seem to us strange indeed, namely, that "the ASME traditionally stays clear of anything smacking of politics."

"The criticism itself is more important than the merits of any single controversy generic to it. Should the engineering societies, in fact, take sides on questions of nontechnical character which are politically controversial? The question is raised with increasing frequency, especially by those who believe that since conditions of work, control of production, economic planning, and governmental activities in the technical field affect engineers, ASME should adopt a position on them.

"The American Society of Mechanical Engineers, according to its charter, is a society for the advancement of the *arts and sciences* related to mechanical engineering. In performing that task to the best of our ability, we deem it our duty to serve *all* of our members and *all* of the public—not just Democrats or Republicans, employers or employees, free enterprisers, or disciples of the planned economy, albeit all of these schools of thought and many others may be represented in our roster of membership.

"Engineering, like art, medicine, and the pure sciences, should avoid, by very design and intent, political entangle-

IN ANSWER TO MR. BLACKALL: Almost every engineer will agree with Mr. Blackall that the professional engineering societies should not take sides on questions of nontechnical character that are politically controversial. To do so would quickly split the membership, create internal discord and undoubtedly would soon destroy the society's usefulness. As Mr. Blackall puts it, ". . . questions of politically controversial character are not within our (the A.S.M.E.) province."

Purely political activity would not be constructive. But quite frequently questions of principle arise, questions that directly concern the engineering profession and concerning which engineers are in a favorable position to answer or act upon without prejudice.

As examples of "political" activities engaged in by other profesisons we have the American Medical Society. Medicine certainly does not "avoid, by very design and intent, political entanglements of every character, except where scientific integrity itself is at stake, and then only on the basis of demonstrable facts."

Of the Bar Associations it is also true that they participate greatly in giving to the public the benefits of their particular knowledge and training. It has been common practice for the Bar Associations to pass upon and make recommendations for appointments to judgeships.

Perhaps one of the brightest records of public service performed by the A.S.M.E. was its sponsoring of the famous "Boiler Codes". These are now known as the Boiler and Pressure Vessels Codes. At the time that the original boiler code was made, the design of such pressure vessels was entirely up to the company building it and the safety laws of the state in which the boiler was to be used. It was obvious that much would be gained by a national standard boiler code that would be acceptable to all 48 states, that would assure greater safety and that would permit uniformity in code provisions.

Now, the boiler code most assuredly involved a tremendous amount of politics. Indeed, the politics of 48 different states was involved. The A.S.M.E. was certainly mixing up in politics when it promulgated the boiler code. And the A.S.M.E. did a wonderful job in the way it handled the whole matter.

Those people who object to the A.S.M.E. engaging in politics will immediately say, "The A.S.M.E. boiler code story is not the kind of politics we are talking about." Of course it isn't, but that is the kind of "politics" in which the A.S.M.E. should engage whenever the welfare of the public and the standing of the profession call for it. The word politics is an extremely loose term and covers everything from ward heeling and lobbying to making laws and directing the lives of the people into specified channels.

Politics also means such things as creating a public un-

Eye on the Ball

ments of every character, except where scientific integrity itself is at stake, and then only on the basis of demonstrable facts. For example, ASME very properly might rise to protest if some legislator should threaten to establish the value of π as exactly 3.1, on the basis that it was foolish to bother with the extra decimals. (Comparable laws actually have been passed!) But questions of politically controversial character are not within our province.

"To those who feel otherwise, we commend a reading of the basic laws and charter of this Society. We are not a trade association; we are not a labor union; we are not a political party; although judging from the mail we receive, we are expected at one time or another to be all three! The propriety of every proposal for the focusing of ASME activity on a new field of endeavor should be judged strictly in the light of the Society's objectives as defined in the Charter and Constitution. In abbreviated form they are:

To promote the arts and sciences in our field
To encourage research
To foster engineering education
To advance the standards of engineering
To provide contact and discussion among engineers and scientists
To broaden the usefulness of our profession.

"To these purposes we direct our energies and our enthusiasm, actively, continuously, vigorously, and we earnestly hope, intelligently.

"Our founding fathers were wise in their construction of our frame of reference. We shall be wise to keep within it. It is no accident that, on those rare occasions when, through misguidance or bad judgment, we step off the reservation, we usually find ourselves in hot water, our house divided against itself. The real opportunity which ASME offers its members for participation in both private and public affairs is to assist them in becoming better-informed, more articulate, and more competent engineers.

"If ASME can do a creditable job in promoting these ends, it will have been true to its aim and destiny. This is not to say that its members, as individuals, should not take forthright positions with reference to the political questions of the hour. The record is full of evidence that they do. But that is not the purpose to which the Society owes its existence. In addressing itself to the task assigned to it, to the complete exclusion of political logrolling, our Society is acting in the best engineering and scientific tradition."

FREDERICK S. BLACKALL, JR., *President*
The American Society of Mechanical Engineers

derstanding of basically scientific and technical problems. And year by year it is becoming more and more important that the public shall have a better appreciation and a better understanding of the problems created by science, engineering and technology. And it is also getting more and more important that certain definite political actions shall be taken to protect the public against possible harm, either directly or indirectly, resulting from technical developments.

The A.S.M.E., through the Engineering Council and the Engineers' Committee for Professional Development has participated very actively in a problem of general public welfare as it relates to engineering education. If one were to suggest that the A.S.M.E. dictate the curricula in engineering courses, the answer will be emphatically no and properly so. But attacking the problem on a broader basis, we have the accredited engineering colleges, the accrediting being done by the E.C.P.D. It is a wonderful thing and it has been extremely constructive and is receiving the support of all major colleges. The accrediting makes almost impossible the continuation of engineering schools that are not properly equipped with either faculty or laboratories to teach engineering.

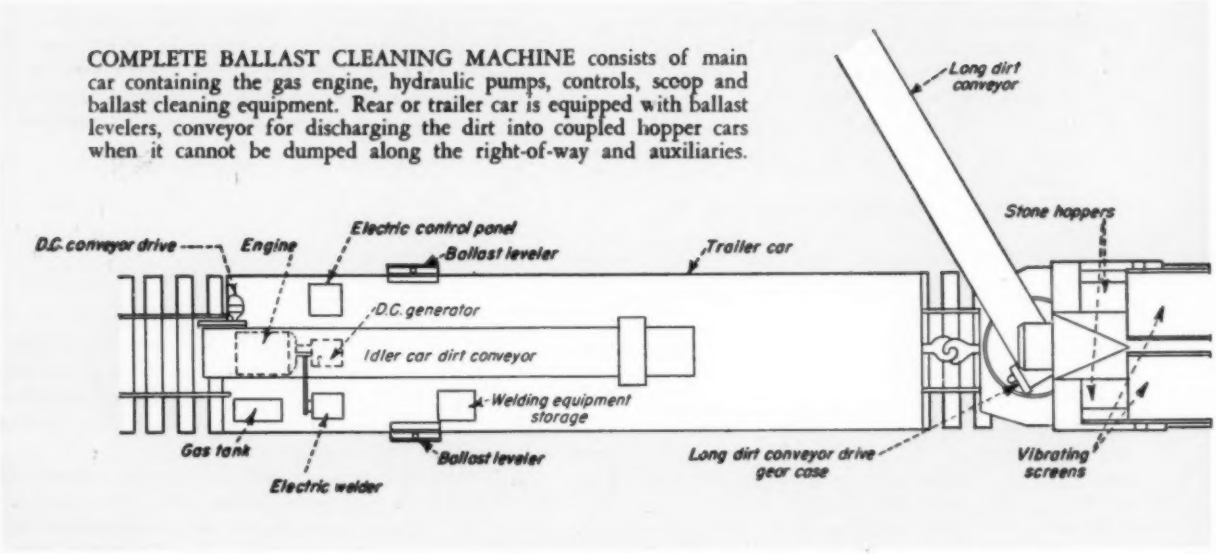
I well remember when the first lists of accredited colleges came out. They were scanned carefully by many alumnae. Some men were amazed because their alma mater was not included on the list. I know of no man who resigned from the A.S.M.E. because of that but I do know of several colleges that made revisions in their curricula and expressed great appreciation for the constructive help given them as a result of the accrediting system.

It is not proper that any individual member should tell the A.S.M.E. or any other society what their activities should be. Only an expression by the membership of the society can do it. To what extent the A.S.M.E. and the other national engineering societies might increase their activities and interest in public affairs is a serious question. The answer to the question might well be obtained by committees of the various societies, appointed by the officers or council of the society to study and report on this extremely important question: "Can our professional society increase its value to the profession and the public by exercising its influence and taking stands in matters of basic principle that affect the public and/or the profession? If so, exactly what should be the scope and limitations of such increased activities in matters of national concern?"

We are convinced that there are many projects and situations, perhaps of a political flavor or significance, in which our engineering societies should become more active, problems that deal with or involve fundamental scientific and engineering principles or that will greatly affect the engineering profession.

DESIGN FEATURES

Railroad Ballast Cleaner Goes Hydraulic



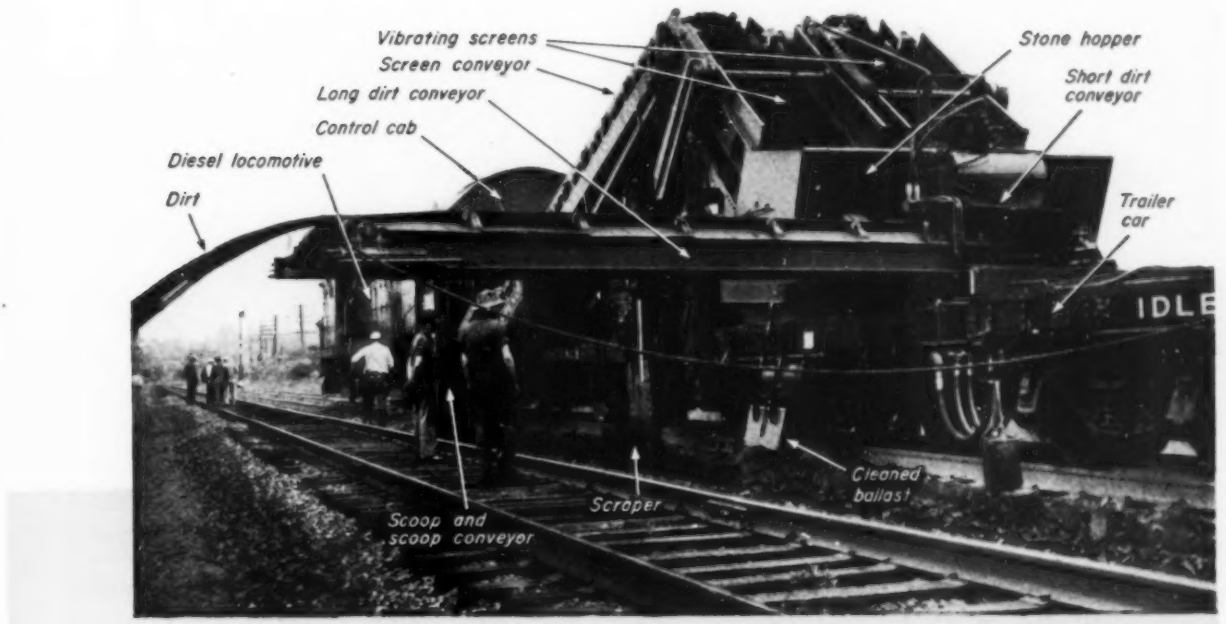
COMPLETE BALLAST CLEANING MACHINE consists of main car containing the gas engine, hydraulic pumps, controls, scoop and ballast cleaning equipment. Rear or trailer car is equipped with ballast levelers, conveyor for discharging the dirt into coupled hopper cars when it cannot be dumped along the right-of-way and auxiliaries.

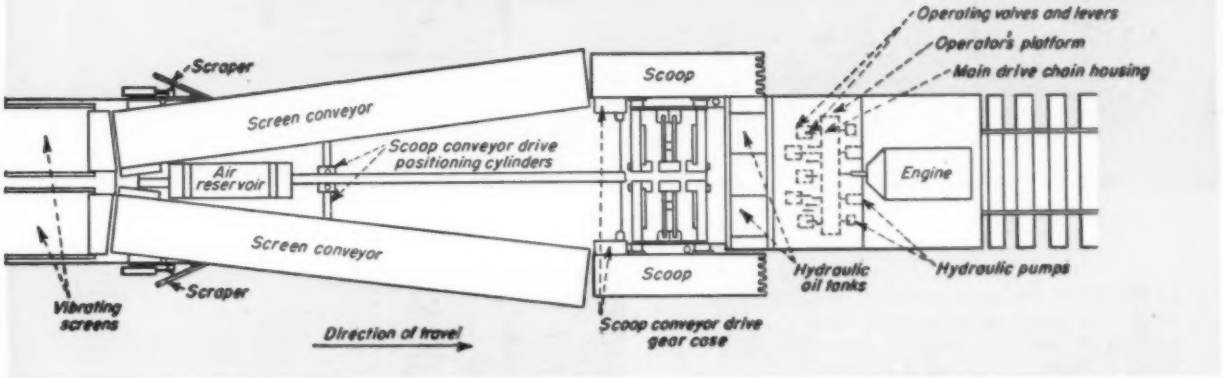
The latest Speno ballast cleaning machines designed by the Holden Engineering Co., Summit, N. J. for screening the crushed stone ballast along railroad tracks to restore proper drainage is completely hydraulically driven. Primary reasons for the change from direct mechanical drives were improved reliability, simplified design and construction, and lower cost maintenance.

Pulled along the tracks by a diesel locomotive at speeds up to 1½ mph, the ballast cleaning machine cleans over 700 tons of ballast per hour. Duplicate controls and operating equipment on each side of the machine permit working either one or both sides of the track. As the machine moves forward, lowered scoops dig into the mixture of dirt and ballast alongside the ties forcing the material onto rapidly moving conveyors which discharge the stone-dirt mixture to longer conveyors for delivery to vibrating screens.

The screened out dirt, 30 to 75 per cent of the volume cleaned, drops into hoppers and onto a short conveyor that feeds it onto a long swivel mounted conveyor for dumping. The dirt can be dumped either along the sides of the right-of-way or onto a transfer conveyor on a trailer car for discharge into coupled hopper cars. Scrapers mounted on the sides of the main car undercut the ends of the ties before the ballast is redeposited. Cleaned stone discharged from the screens into stone hoppers is fed back into the trench through adjustable discharge gates. Levelers on the trailer car are then positioned

IN NEW PRODUCTS



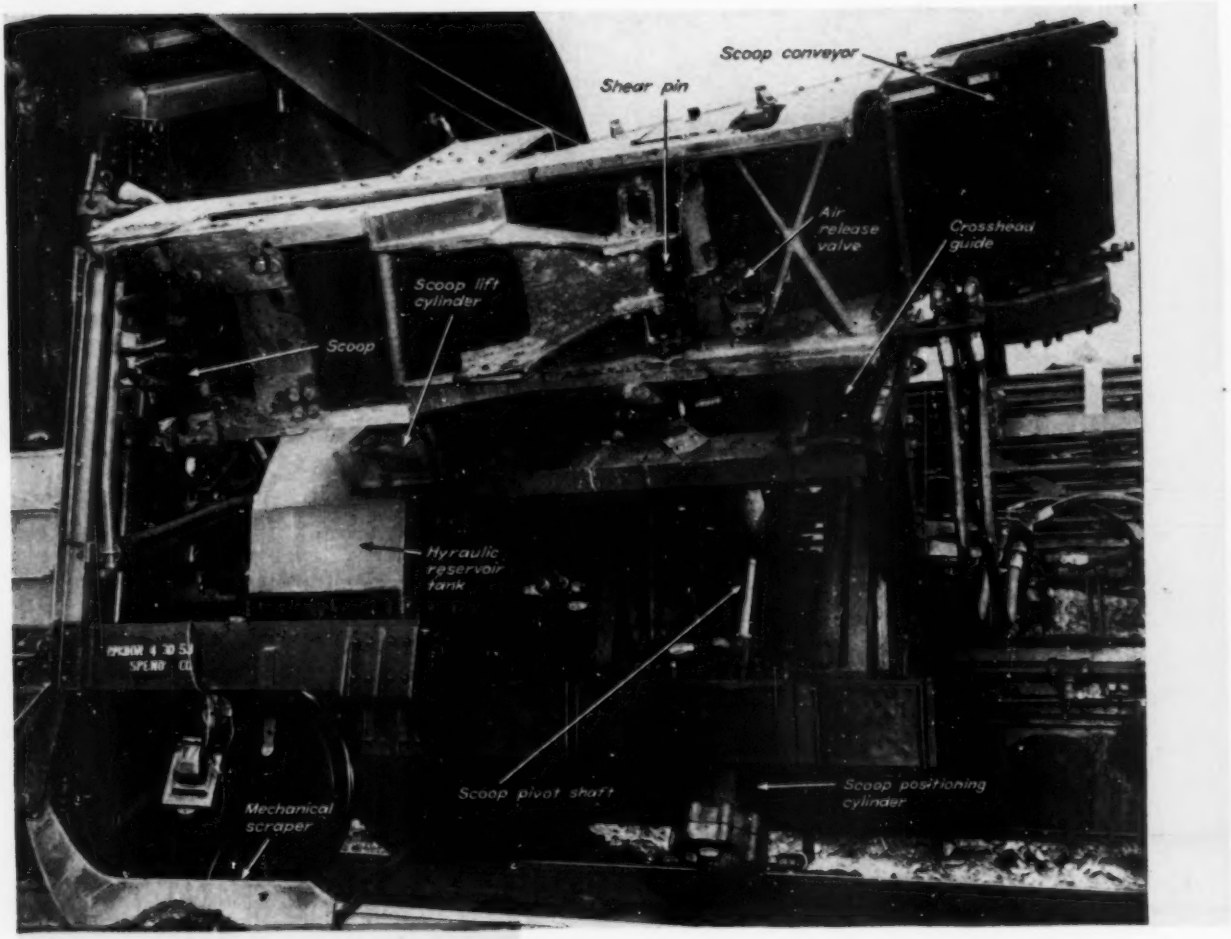


hydraulically to spread the cleaned ballast evenly.

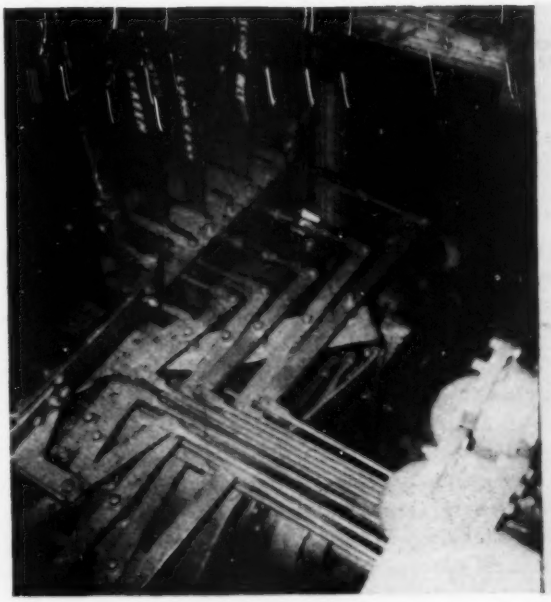
Adoption of a complete hydraulic system paved the way for a marked simplification of the control and operating units. Segregation of the hydraulic circuitry into basic systems gave a direct and dependable control over individual operations. Overload protection and automatically controlled speeds were built into the systems through relief valves, flow control valves and variable orifices.

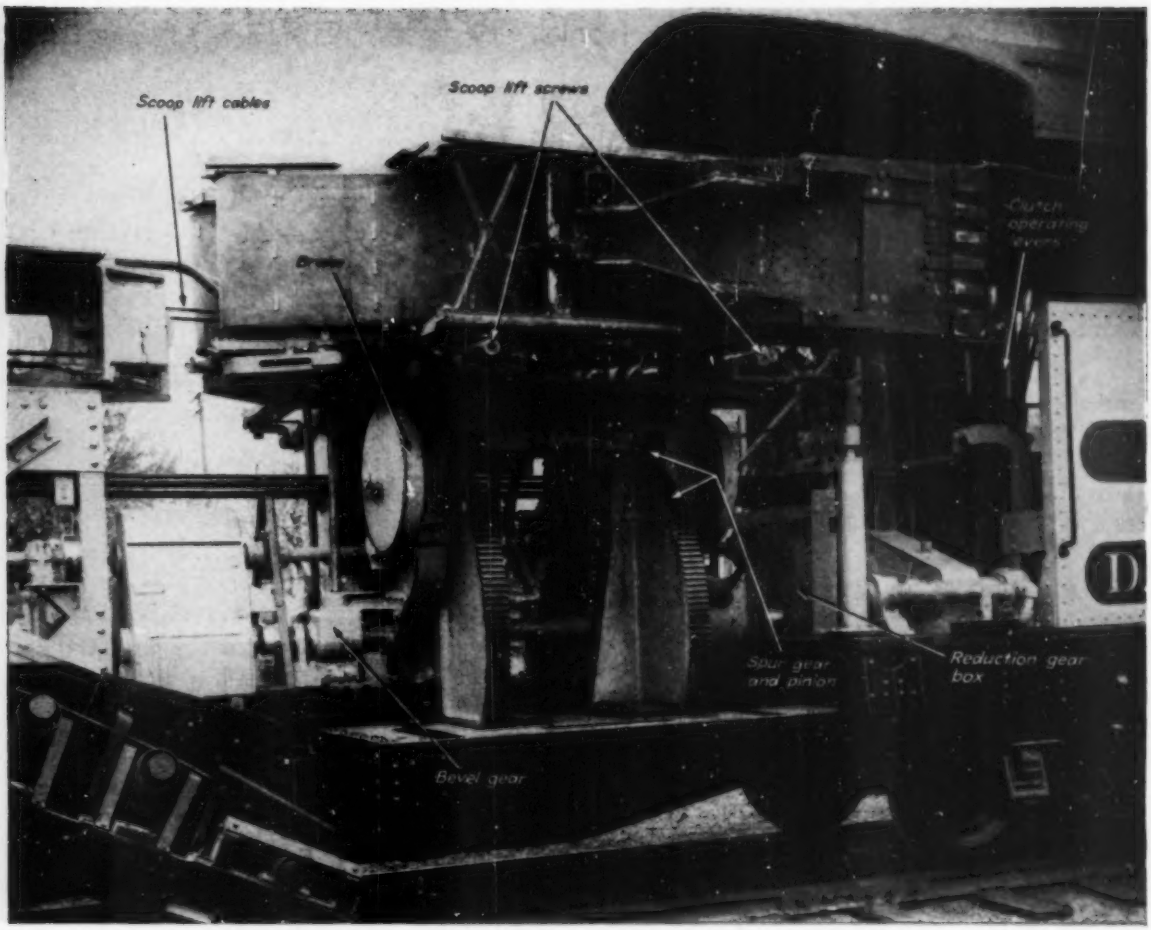
A gas engine drives 9 variable delivery pumps, each connected to one or more hydraulic motors driving operating components. Steel tubing and rubber hose replace the shafting used in the mechanical machines. Multiple control valves in the control pulpit then select the proper hydraulic circuit, depending upon the operation desired by the operators.

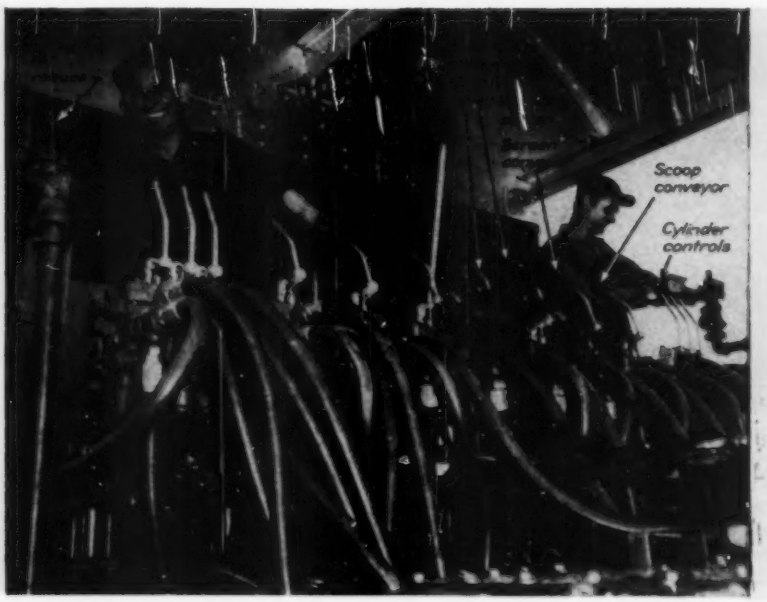
Biggest advantages are elimination of mechanical adjustments, need for practically no lubrication and minimization of wear throughout the machine. In the mechanically driven machines, screen vibration and wear caused continuous readjustment of clutches and drives. Dirt caused rapid wear of working parts, and proper lubrication was both difficult and time-consuming. The many specially designed accessory drives and components were relatively costly to fabricate and replace. In the new machines, unitized design makes possible rapid replacement of damaged parts or assemblies and cuts down on costly down time. *(continued on next page)*



(ABOVE) A trunioned hydraulic cylinder rotates the scoop around a pivot shaft to position it for the scooping operation. Scoop is shown in its mid-point position, working position is down and transporting is up. Lift cylinder raises or lowers the scoop to give the desired depth of cut. Should the scoop strike an obstruction, the increased force will shear a cast iron pin allowing the scoop to move back contacting an air release valve and stopping the machine. Scoops in older machines were pivotted by a hydraulic cylinder pulling steel cables rolling the pinions on large spur gear segments. Pinions were geared to automatic band brakes which, if the cables snap, would immediately set to prevent downward movement of the scoop. Vertical movement of the positioned scoop was done by large feed screws driven through a clutch and special bevel gear design, power being taken from the main shaft through a bevel gear box.

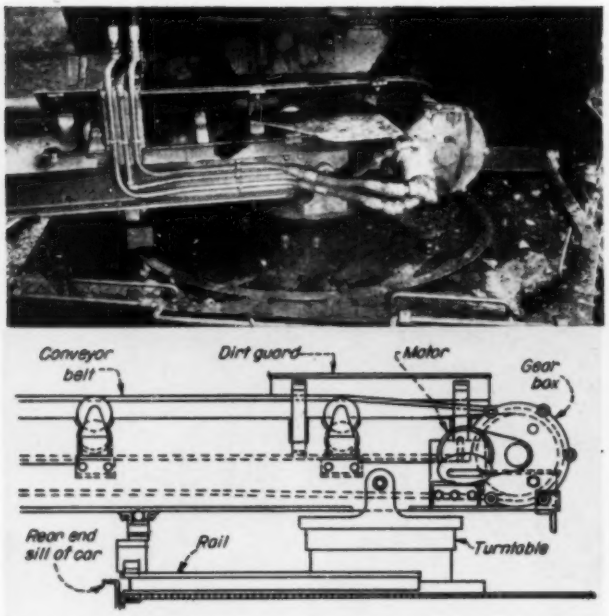




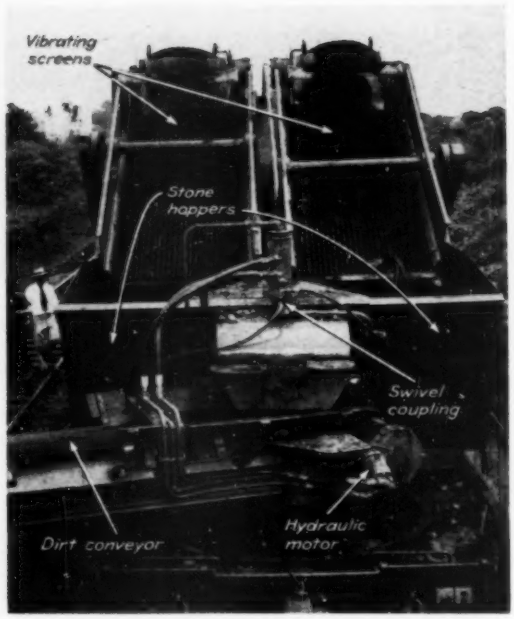


CONTROL CAB contains the hydraulic controls, a duplicate set for each side of the machine to allow single or simultaneous operation. Simple movement of the control valve levers stops or adjusts any of the 15 operations on the machine. At the far left is the maze of control levers and linkages required on the mechanically driven machines. In new design, hand operated pump is used to raise the scoops should the main pump or motor be inoperative. Air release valves tied into the air brake system of the train allow either operator to stop the machine if an emergency arises.

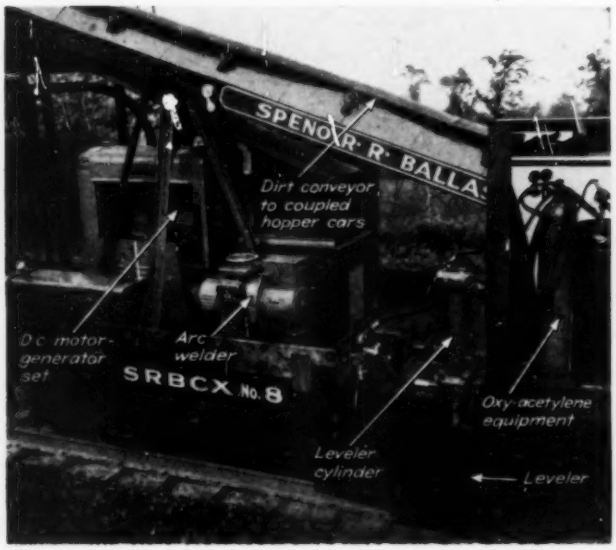
(continued on next page)



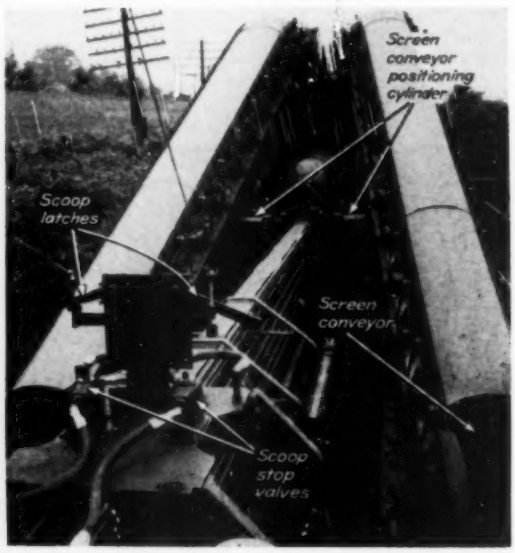
BOOM CONVEYOR for discharging dirt along the right-of-way is supported by a turntable and cantilever arrangement. Free to pivot laterally, weight of the conveyor is transferred to a circular rail through a wheel yoke mounted on the bottom of the conveyor frame. This design places an upward thrust on the turntable, the force being counteracted by a large spherical roller bearing within the turntable housing.



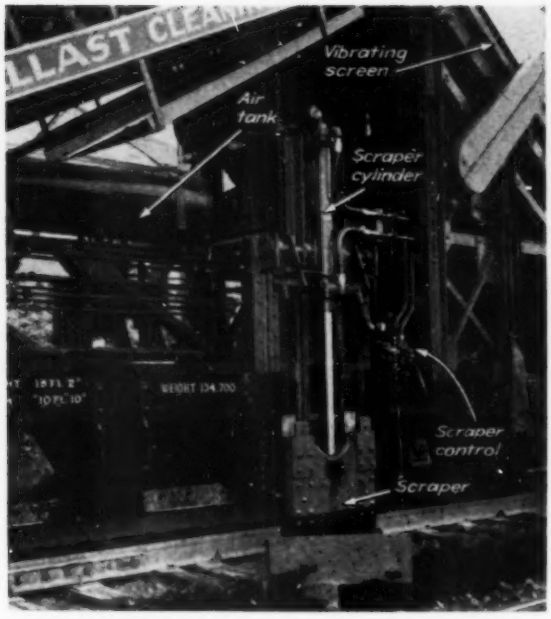
BALLAST is separated from dirt by vibrating screens, the dirt being conveyed to a dirt conveyor boom for discharge either along the right of way or into coupled hopper cars. The ballast falls into stone hoppers for redepositing in the scooped out trench. Driven by a hydraulic motor, the dirt conveyor is free to turn, position being manually regulated.



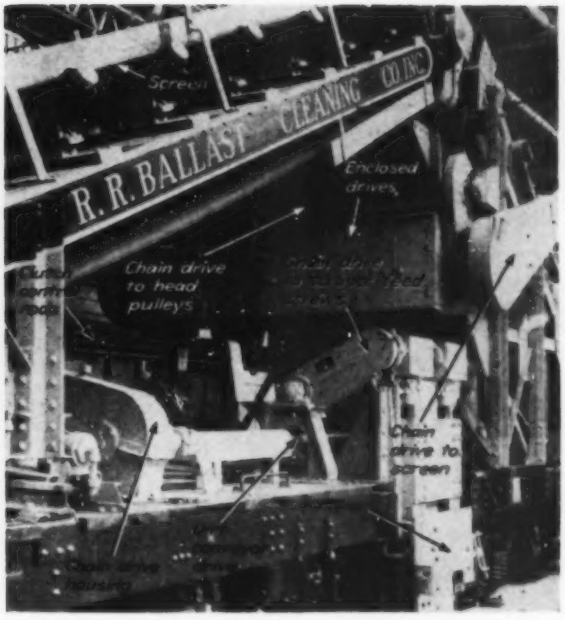
TRAILER CAR coupled to the machine contains a dc motor-generator set to supply power for operating the dirt conveyor section on the car and for the conveyors mounted on hopper cars to the rear. Also on the idler car is the hydraulic leveling unit which smooths the surface of the cleaned ballast discharged into the trench. Control for the leveler is hydraulic and is connected to the main circuit. Trailer car also carries maintenance gear.



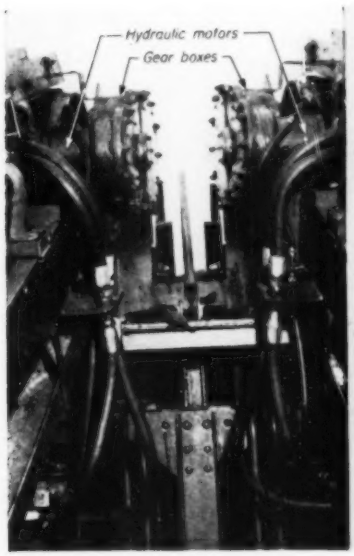
TO POSITION the screen conveyors to pick up the discharge from the scoop conveyors, hydraulic cylinders move the conveyors about their top pivot. Also shown is the scoop stop arrangement which consists of hydraulic release valves to automatically stop movement of the scoop and mechanical latches for positive locking of the scoops in their up position.

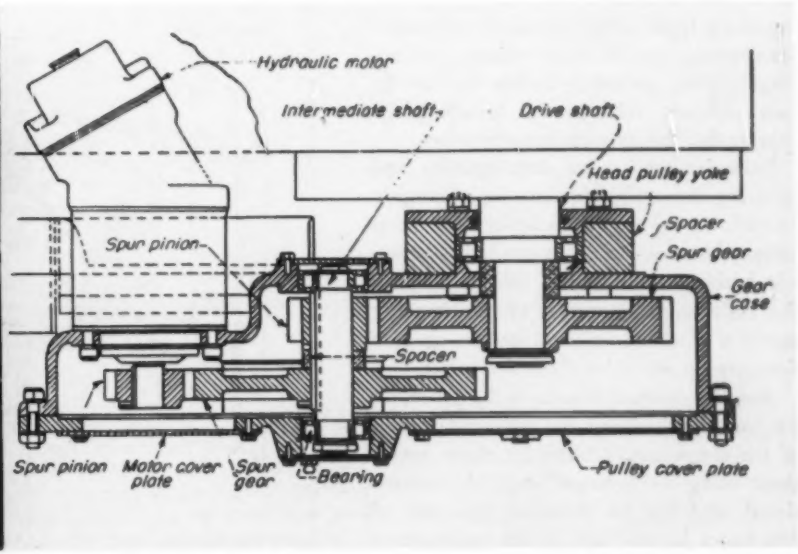


REAR SECTION of the machine is equipped with the hydraulically operated scraping unit for undercutting the ballast under the ties. Controls to operate this component are next to it. Screen conveyors and vibrating screens are driven by hydraulic motors controlled from the control pulpit. Reason for the localized control of the scraper units is to give a visual check on the depth and angle of the blade.



SCRAPER UNIT in older models was positioned by two feed screws turned by power transmitted through a clutching and bevel gear arrangement from the main shaft. To permit swivelling of the screen conveyors from their closed to working positions, the drive shaft consisted of universal and slip joints connected to several gearing and chain drive sections, many of them being of special design.





CONVEYOR HEAD PULLEYS are driven by hydraulic motors through specially designed gear boxes. Hydraulic motors and gear boxes are completely sealed units and quickly replaceable. Operation of the hydraulic motors is controlled by the operators in the control pulpit, either one or both being driven at one time. The motor drive is transmitted to a spur pinion at the end of the motor drive shaft and engaging a spur gear on the intermediate shaft. Keyed to the other end of the intermediate shaft is a spur gear engaging another spur gear on the pulley drive shaft. This drive shaft is then connected to the conveyor pulley driving the screen conveyors to discharge the dirt and ballast onto the vibrating screens. Where standard models were not available, standard parts were used to build units.

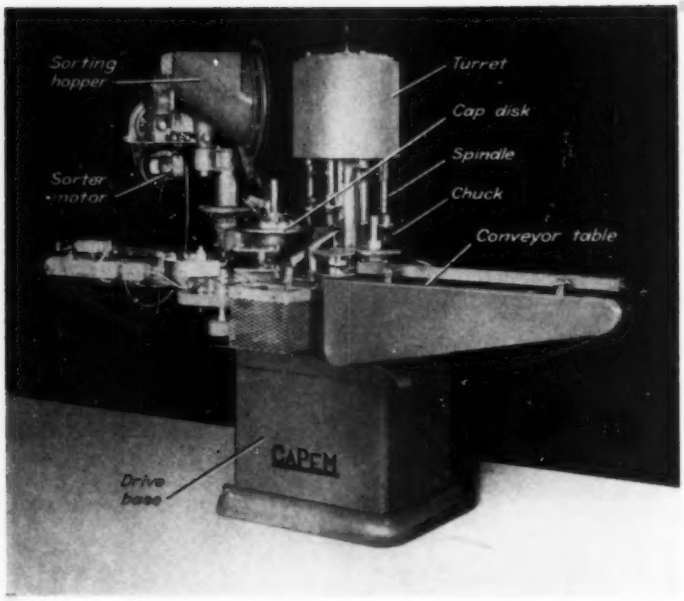
Turret Cams Control Rotary Capper

A rotary capping machine that applies conventional threaded caps to moving containers with an uniform amount of torque —Consolidated Packaging Machinery Corporation's Model "C" Capper—has the entire control mechanism contained within a rotating turret.

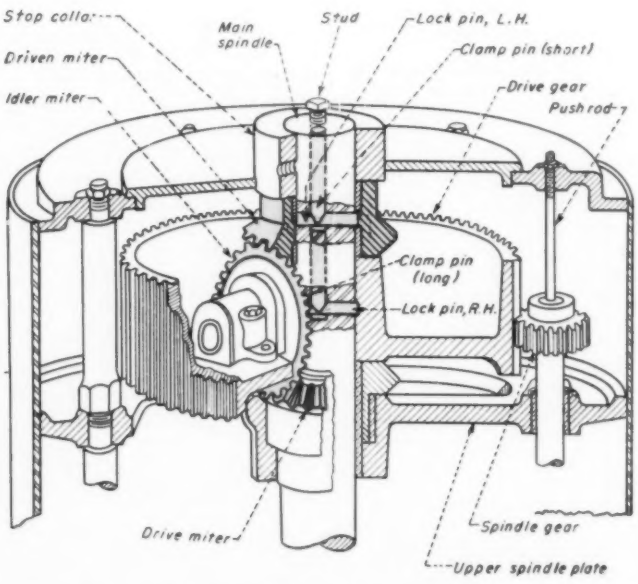
Mounted horizontally within the turret and pinned to a stationary shaft are the spindle, gripper and compression cams. Cam rollers attached to the spindle shafts by yokes ride on the spindle cam surface and below the compression cams. The gripper cam is secured underneath the spindle cam, and is used to actuate the mechanical pivoting of a gripper block to hold the container for capping. As the turret rotates, the capping spindle cam rollers follow the spindle cam contour, raising and lowering the spindle for the appropriate operation.

Built for mechanical dependability and servicing ease on production line packaging operations, the capper incorporates several unique features. Among them is the eccentric bushing arrangement for disengaging the main drive. Rotation of the bushing moves a worm away from its mating gear disengaging the drive from the turret.

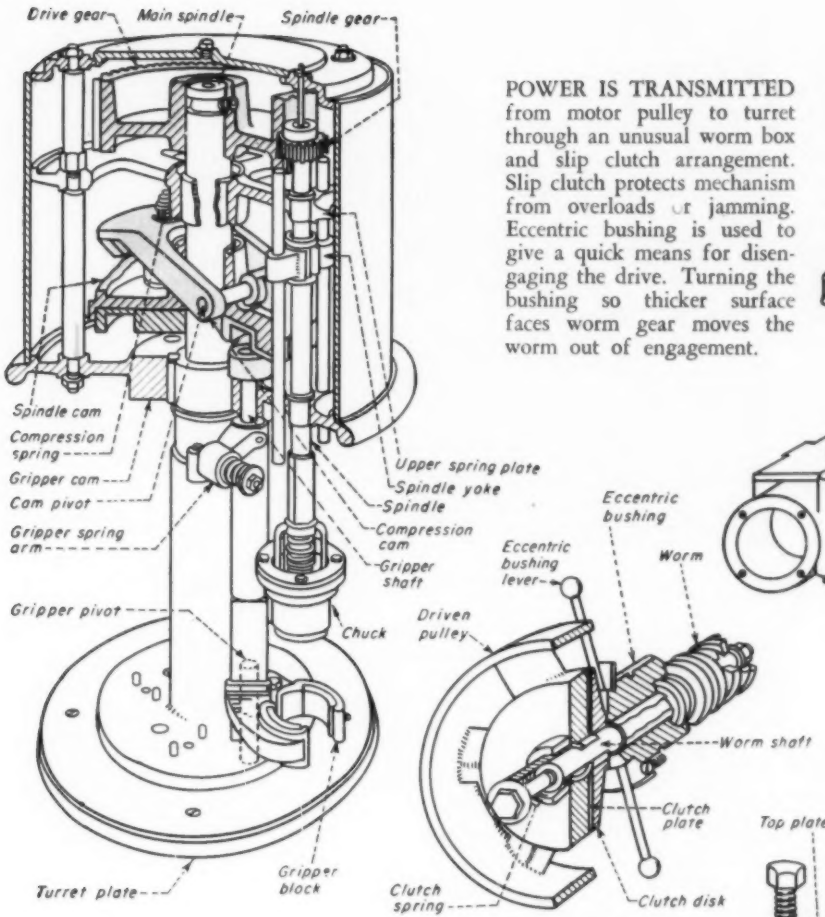
Another unusual feature is the provision for quickly changing the rotational speed of the turret and spindles for those operations using a "twist-on" cap. A conventional stud can be threaded into one of two holes in the top of the main turret spindle. Set horizontally in the holes at different depths are sets of two pins which when the stud is threaded between them, are wedged against either the main drive gear for normal rotation or against a small miter gear for reduced speed.



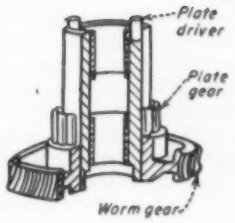
THE CAPPER'S three principal operating sections are the turret containing the capping spindles, the sorter for rearranging the caps and depositing them for spindle pick-up, and the conveyor mechanism which moves the containers in time with the turret operation. The turret, cap disc, and conveyor are driven by one motor; the sorter has its own power.

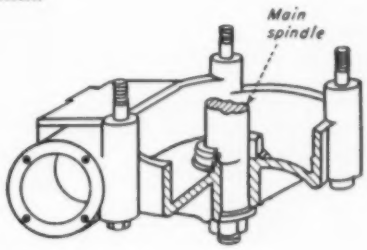


NORMAL ROTATIONAL SPEED occurs when stud is threaded into longer hole forcing lock pins against the hub of drive gear. For slower speed, stud is repositioned in short hole and a pair of lock pins are wedged against the hub of a miter gear. Miter gear meshes with an idler mounted on main drive gear turning the drive gear at reduced speed.

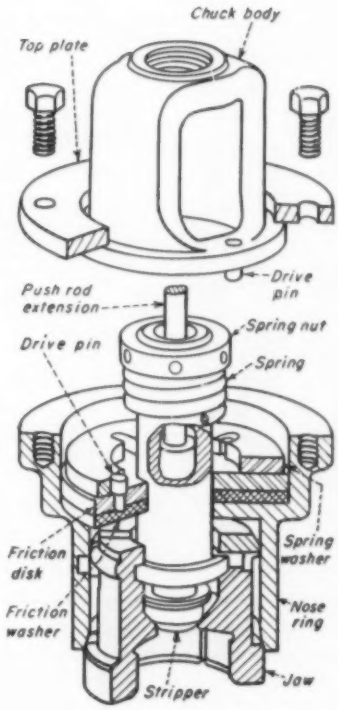


POWER IS TRANSMITTED from motor pulley to turret through an unusual worm box and slip clutch arrangement. Slip clutch protects mechanism from overloads or jamming. Eccentric bushing is used to give a quick means for disengaging the drive. Turning the bushing so thicker surface faces worm gear moves the worm out of engagement.





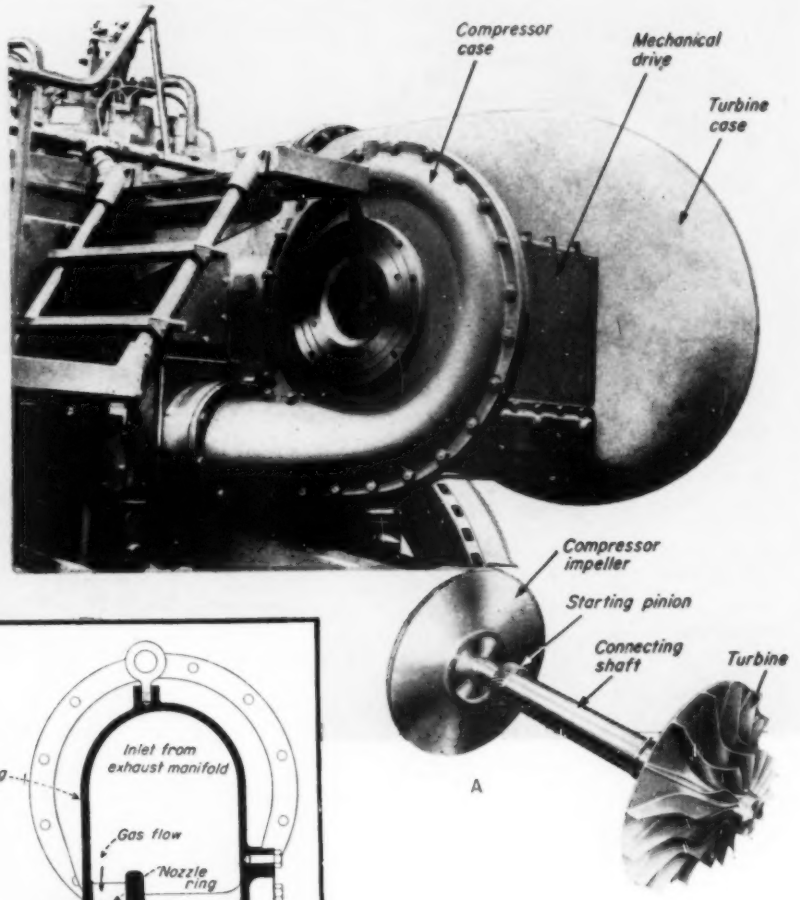
WHEN THE TURRET ROTATES, the compression, spindle and gripper cams are stationary. Turning of the drive gear rotates the spindle through the spindle gear. Raising and lowering of the spindle occurs as the rotating spindle cam roll moves around on cam surface. Gripper cam roll turns on its cam and actuates gripper block. Added threading torque is achieved by compressing spring on compression cam moving it closer to spindle cam where it is in position to contact spindle cam roll.

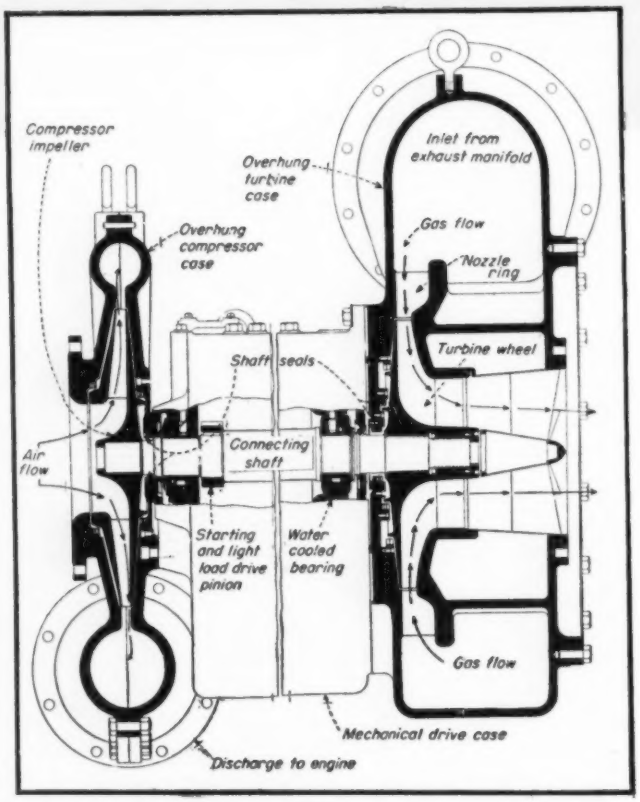


WHEN SPINDLE CAM raises spindle, push rod extension contacts a fixed push rod driving the stripper down and forcing the chuck jaws open. As spindle is lowered, and push rod extension moves away from push rod, the chuck spring pulls up the stripper into recess in the chuck jaws. Slight upward movement of the jaws against tapered nose ring quickly snaps jaws into closed position.

Vertical movement of the spindle is all that is used to open and close the chuck jaws. Once the preset torque is reached in the cap threading operation, the jaws will slip on the friction disk until the spindle is raised ending the threading action.

TURBOCHARGER UNIT is mounted on the compressor end of Clark Bros.' new two-cycle right angle gas driven compressor. Turbine and compressor cases overhang the drive housing to prevent the contamination of fresh incoming air by exhaust gases, and the possibility of exhaust gases and air under pressure entering the engine crankcase through the drive housing. (A) Radial inflow turbine wheel drives the centrifugal impeller wheel through an integral connecting shaft. Starting pinion is engaged to operate turbocharger at start-up and light loads.

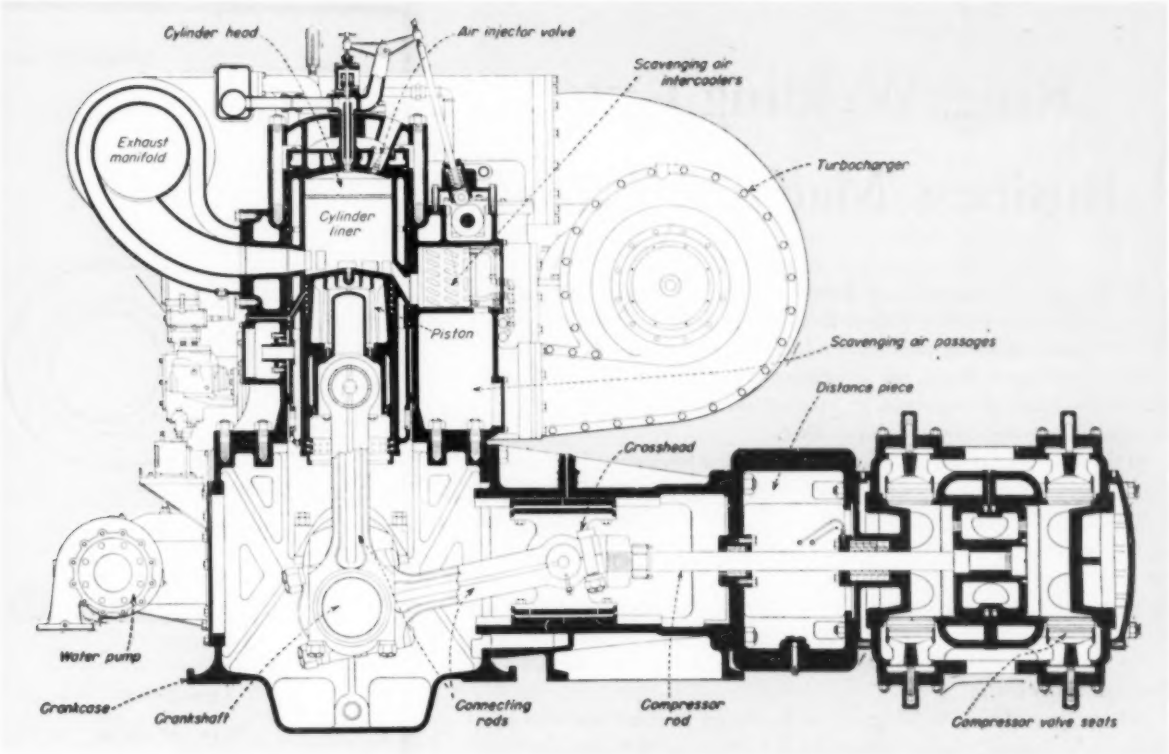




GASES from exhaust manifold enter turbine wheel at periphery and exhaust through the center of the wheel after giving up sufficient energy to drive the compressor impeller. Energy is obtained by taking a 5 to 7 psi drop and a 100 to 150 F temperature drop from gases passing through the turbine.

Turbocharger

A turbocharger consisting of a single stage inflow turbine integrally connected to a single stage centrifugal compressor impeller recovers sufficient heat from the exhaust gases to supply the necessary volume of air under all load conditions for scavenging and combustion in Clark Bros. Co.'s new two-cycle gas engine driven compressor. Turbocharging enables the compressor unit to develop 50 percent more power, burn 10 to 15 percent less fuel and use 25 percent less water for cooling than its predecessor model of similar displacement. Usual arrangement is to



TURBOCHARGED UNIT consists of eight vertical inline power cylinders and four horizontal compressor cylinders, all connected to the engine crankshaft. Supercharging level is automatically proportioned to the engine load keeping the combustible mixture within satisfactory limits over a wide range of load conditions. Turbocharger also acts as a restriction in the exhaust line making the compressor unit operate at a back pressure. This makes it possible to supercharge the cylinders with a greater weight of air than if exhaust operated at atmospheric pressure.

Increases Compressor Efficiency

pump air for scavenging and combustion with either reciprocating scavenging cylinders directly connected to the engine crankshaft or with some type of positively driven blower.

A completely self-contained unit, the new turbocharger consists of three main sections: turbine, mechanical drive and compressor assemblies. Exhaust gases enter the turbine wheel at the periphery and are discharged at the center. At the other end of the connecting shaft, air enters the eye of the compressor impeller and is discharged to a volute attached to the main scavenging air passage of the gas engine driven compressor. Since insufficient heat is present in exhaust gases at engine start-up and at light loads, the turbocharger is initially driven by a heavy roller chain operating off the engine crankshaft and through high speed gears in the mechanical drive housing. Under normal load conditions, the turbine wheel operates independently of the crankshaft, the speed being determined by the amount of heat in the exhaust.

To retain as much exhaust velocity as possible to drive the turbocharger, all passages in the engine cylinder liners and block as well as the lead in passages in the exhaust manifold are highly streamlined to curve in the direction of the turbocharger. Radiation heat losses are minimized by fully insulating the exhaust manifold.

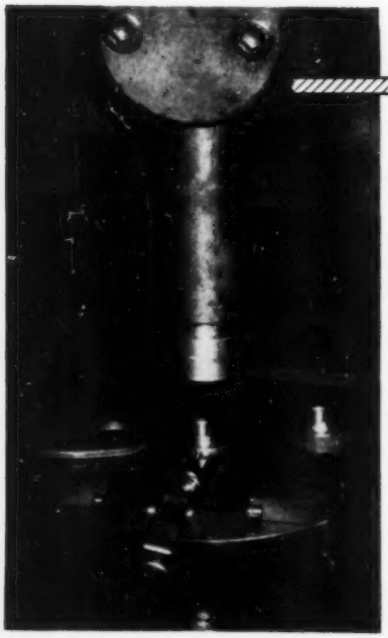
The turbocharger was designed to match the operating range characteristics of Clark's right angle gasoline driven compressor. To take advantage of the increased power developed, the gas driven compressor was redesigned to maintain same overload capacity as the previous model.

Ring Welding Cuts Business Machine Costs

Because of the hundreds of screw machine parts and flat stamped pieces used in the construction of modern business machines, the use of ring projection welding to eliminate former costly processing operations enabled Remington Rand, Inc. to produce a new Low Cost Bookkeeping Machine—a unit priced about 50 percent less than comparable multiple function machines now on the market.

In the manufacture of a typical component, a projection is turned on the screw machine part by a forming tool and then the part is used with a stamping or a flat or formed part to make the assembly. By the application of this production method, the countersinking of flat pieces, spinning or brazing of the hub to the piece, and the balking or reaming operations common to the spinning process are eliminated. In Fig. 1, a comparison between the manufacture and assembly of a conventional component shows ring welding to save six manufacturing steps over the former method.

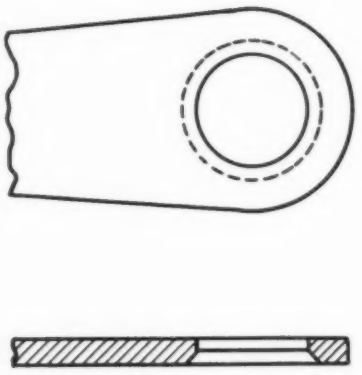
Advantages of ring welding are to insure no interference with adjacent moving parts by using hubs with the tenon shorter than the blank thickness. If the part is to be used as a spacer, the tenon of the hub can be designed to eliminate extra machining. This feature also makes it unnecessary to hold the thickness of a flat section to any close limits when it is to be assembled to a hub.



TYPICAL SET-UP for ring welding hub to a flat pierced stamping. Hub is inserted in a fixture and the flat arm is placed in position. Resistance welding machine makes a uniform circular weld between the tapered hub ring and the arm surface. Methods of preparation for this form of projection welding are frequently specified to suit particular conditions. Final assembly will generally represent a cheaper production process giving an assembly difficult to separate.

SPINNING AND

Fig. 1



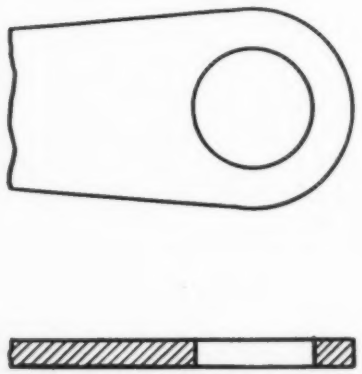
Component

1. Blank and pierce
2. Tumble to remove burrs
3. Countersink as indicated

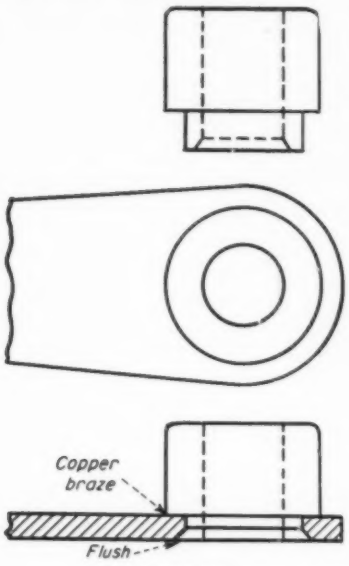
RING WELDING

Component

1. Blank and pierce
2. Tumble to remove burrs



BRAZING METHOD



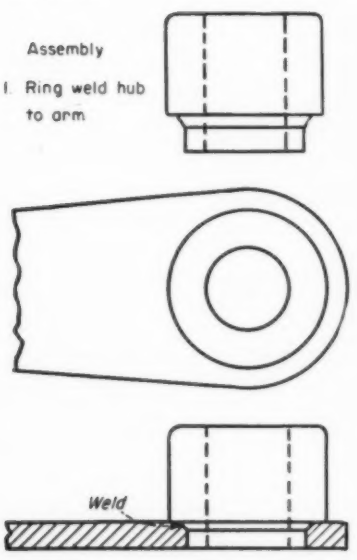
Assembly

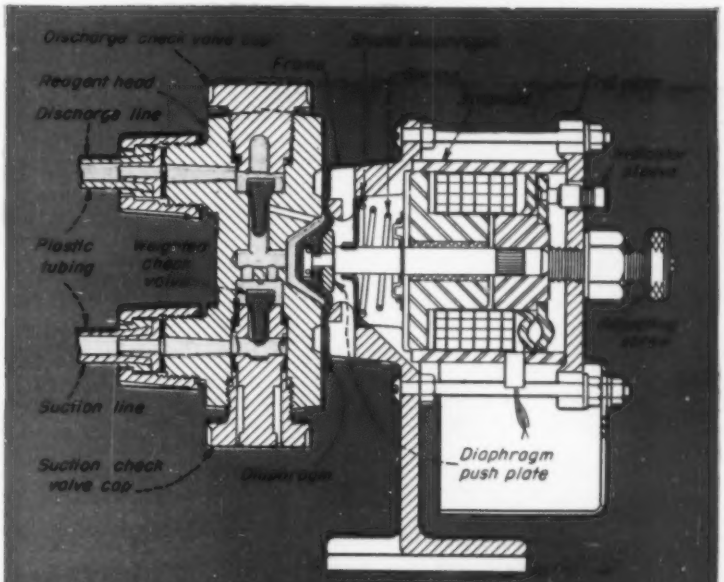
1. Assemble and spin hub to arm
2. Copper braze
3. Strip copper
4. Flush as indicated
5. Ream hole to remove spinning burr
6. Re-heat treat

METHOD

Assembly

1. Ring weld hub to arm





ENERGIZING THE SOLENOID pulls in the armature moving the diaphragm to the left displacing a definite volume of solution out past the discharge valve into the feed line. When de-energized the spring return moves the armature and diaphragm to the right against the adjustable stop allowing a regulated volume of solution to flow in past the suction check valve from the supply line, plastic head visually showing flow.

Flexible Diaphragm Acts As Pump Piston

Using timed electrical impulses to energize a solenoid for controlled feeding of solutions into chemical systems operating at 50 psi or less and at flow rates up to 50 gpm is the principle behind Proportioneers' new Chem-O-Mite pump-feeder. A neoprene diaphragm attached to the end of a spring loaded solenoid armature takes suction and discharges the solution under pressure. The amount of discharge is controlled by limiting the spring returned travel of the armature which determines the volume of solution drawn into the unit on the suction stroke. This volume is then discharged as the solenoid is energized.

A power pack is furnished with the pump to supply the electrical impulses to actuate the solenoid. The power pack can be constructed to energize the feeder for constant rate or intermittent constant rate for flow proportional feeding.

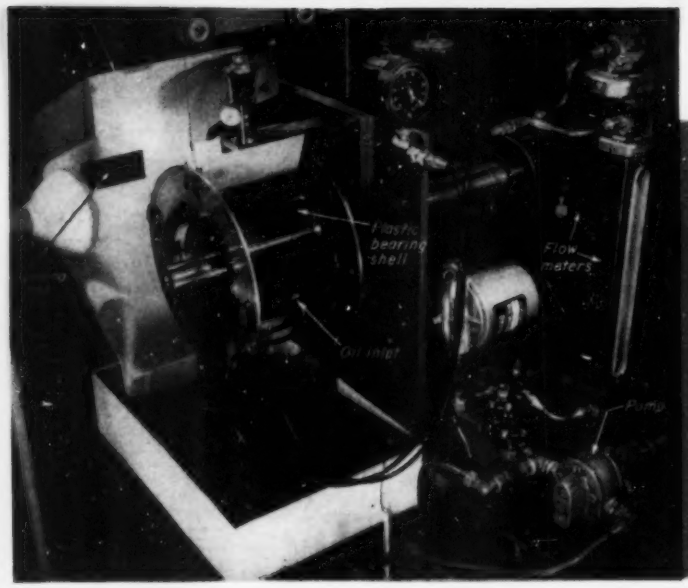


Fig. 1—Equipment used to make "streak-photographs". Lubricant from flow meter enters the bearing shell as shown. Camera (not shown) is located in background and aimed through slot in sheet metal reflector.

Fig. 2—(Right) Set of three flow pictures for a 360 deg journal bearing, 4½ x 4½ in., running at 100 rpm under a total load of 15 lb. Lubricant enters the bearing just to the left of the dark circle on the centerline. The streamline envelope visible to the left of the inlet marks the boundary between incoming lubricant and that which has already passed around the bearing. Pictures shown in (A)-(C) used in conjunction with known operating data, are useful in studies of circulation and temperature gradients in the lubricant film. They provide a ready means of comparing the effect of oil grooving on lubricant distribution.

Study of Lubricant Flow in Bearings By Streak Photography

FRANK J. KOLANO
Research Laboratories
Westinghouse Electric Corporation

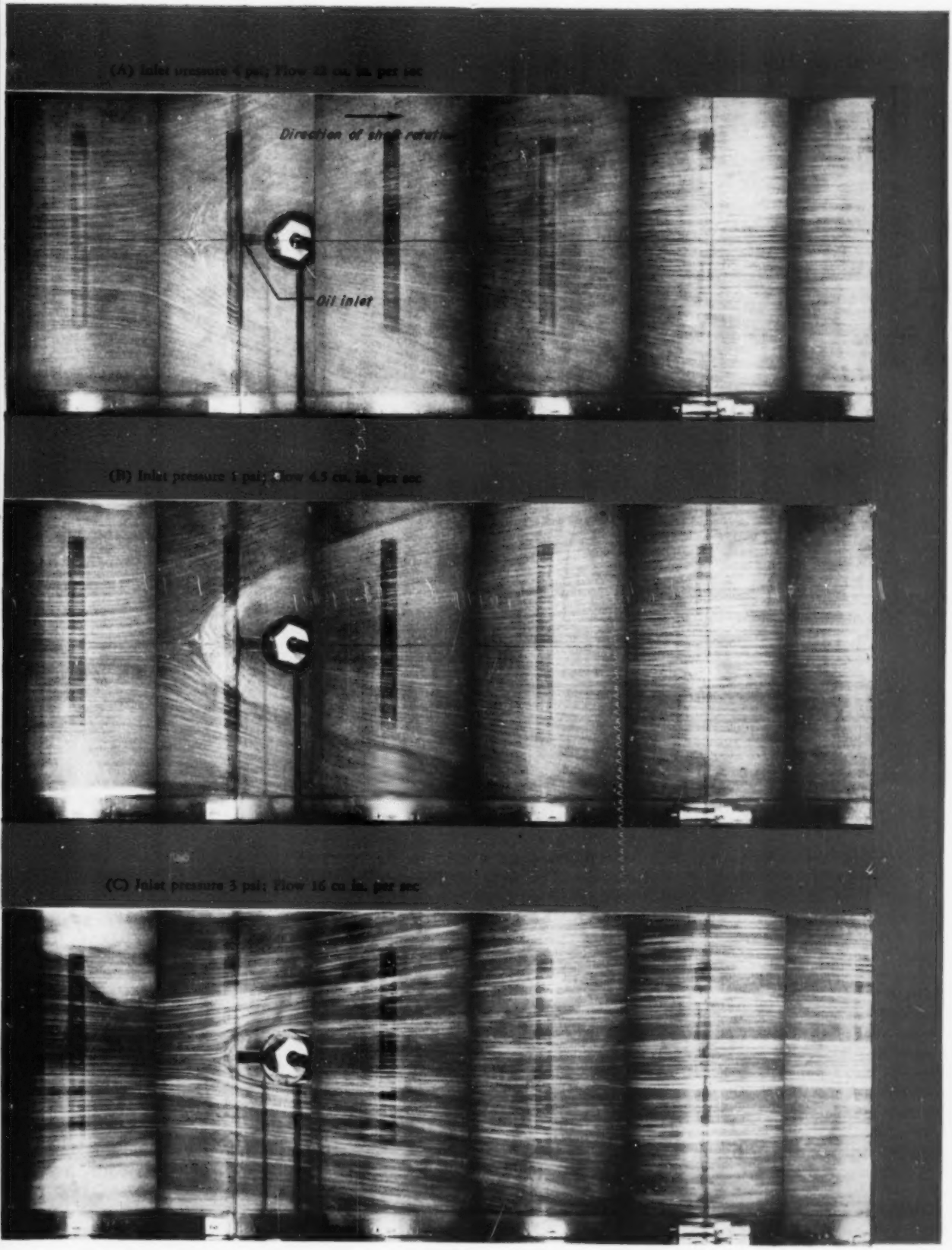
IN STUDYING the use of oil as a bearing coolant and lubricant, a clear, accurate picture of the path that it follows in passing through a bearing can be an invaluable aid to improved designs. One way of getting such pictures is with the transparent plastic bearing shell and the associated equipment shown in Fig. 1. By the use of special techniques, the lubricant flow is made visible and can be followed from the time it is introduced at the mid-point of the bearing until it flows out the ends.

One common method of making flows visible is to introduce finely divided solids such as powdered aluminum, shredded paper or cork dust into the fluid under study and let the particles be carried along by the stream. Short time exposures of such flows give pictures containing a large number of short streaks whose length is proportional to flow velocity, and whose orientation indicates flow direction. The pictures are aptly called "streak photographs."

In adapting this method to bearing studies, it was found that solid streak producing materials could not be used. If solid particles are made large enough to be seen and photographed, there is always danger that they may clog the smaller passages, either damaging the apparatus or changing the flow characteristics. Substituting a finely divided fluid in suspension removes this danger; the droplets simply flatten at constricted locations and pass on with the main flow.

Although oil is the lubricant used in most full-sized bearings, similitude requirements dictated the use of kerosene in this smaller laboratory model to attain comparable operating conditions. The kerosene was colored dark red with an oil soluble dye while a clear solution of glycerine in water was used as the streak-producing medium. When the mixture passed through fine screens in the lubricant supply line, the glycerine-water solution broke up into small droplets and was carried along by the kerosene. The flow pattern was then recorded on orthochromatic film.

To keep perspective distortion within reasonable limits, the camera-to-bearings distances were set at three feet and only 60 degrees of the bearing arc was recorded in a single photograph. The bearing shell was turned 60 degrees between pictures so that a full 360 degree flow pattern could be recorded. Adjacent pictures were matched by reference marks on the inner bearing shell surface.

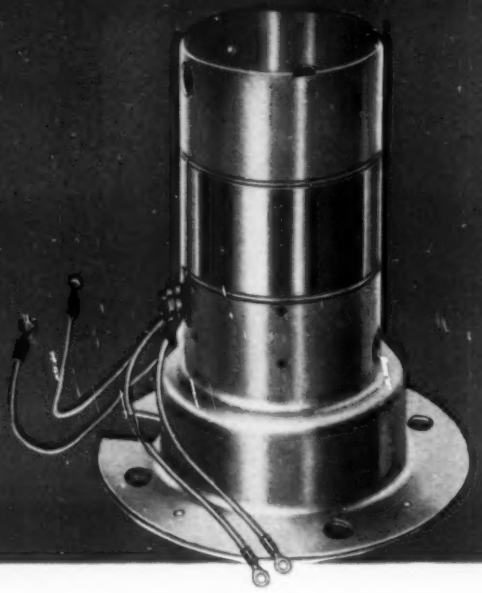


(A) Inlet pressure 4 psi; Flow 23 cu. in. per sec

(B) Inlet pressure 1 psi; Flow 4.5 cu. in. per sec

(C) Inlet pressure 3 psi; Flow 16 cu in. per sec

Film-Type Heating Elements



Coating of thermosetting resins and metallic pigments maintains desired temperature of surfaces on which they are sprayed.

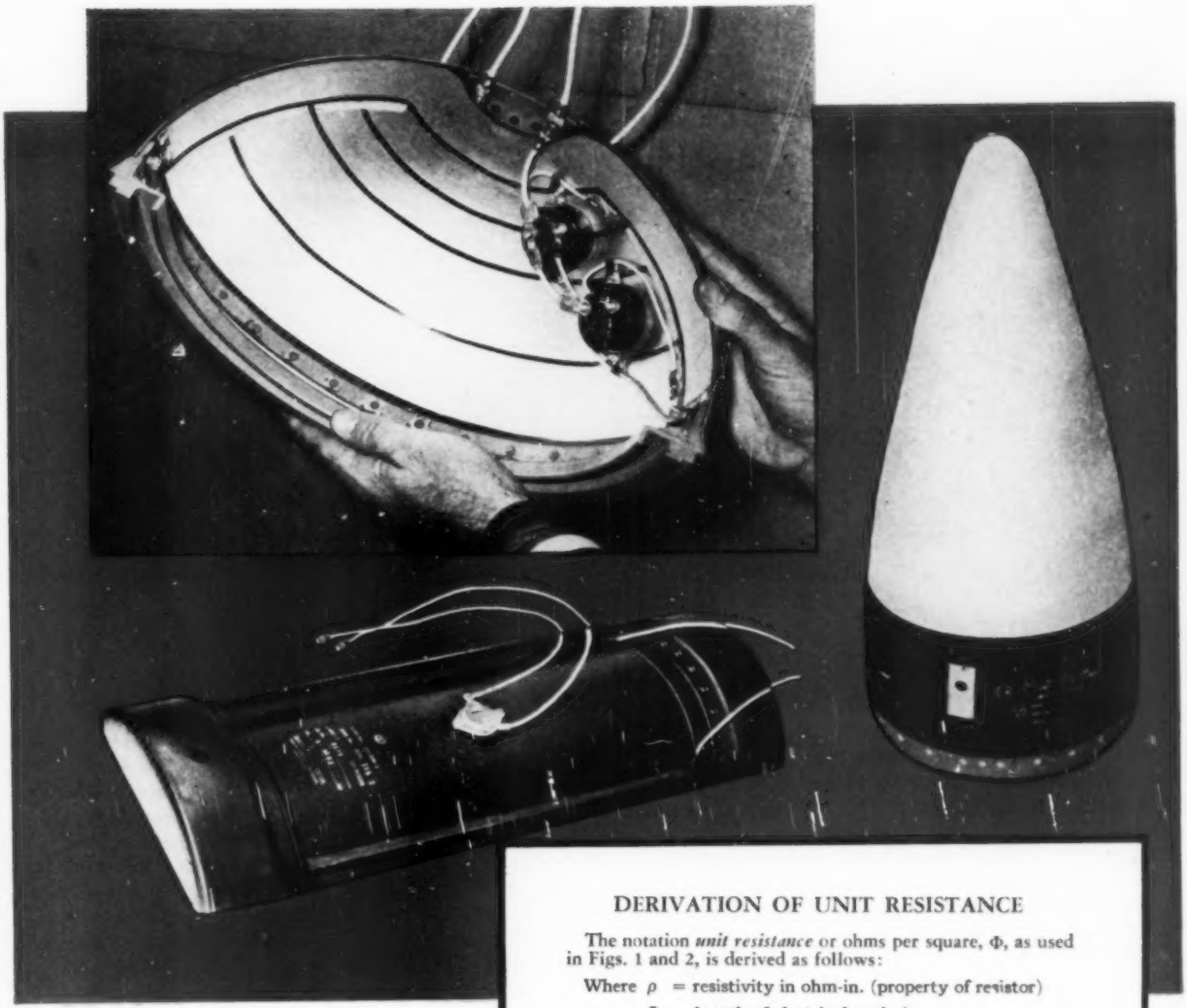
R. E. CRUMP
Electrofilm Corporation
North Hollywood, Calif.

AN ELECTRICALLY CONDUCTIVE "paint" film composed of thermosetting resins and metallic pigments dissipates heat at 300 F from any insulated surface. Distinguishing characteristics of this film type resistance heater are: Light weight—less than 0.1 lb/sq ft including electrical connections; small mass of heat source, which is advantageous in thermal transients; thin insulation between heat source and part to be heated; uniform surface temperature resulting from physical division of total power throughout area heated; and ease of application, particularly to curved areas.

Electrofilm is not a paint in the strict sense of the word. But like some paints it is a formulation of a resin of controlled solids content, milled metallic pigments and graphite. And, like most baking enamels, it must be cured at elevated temperatures. This curing cycle is divided into three stages in order to establish the desired film qualities: (1) A half-hour flashing period at 150 F during which all residual solvents are evaporated; (2) a pre-polymerization period at 400 to 500 F (depending on the molecular structure of the thermosetting resin selected); and (3) main polymerization period at optimum temperature for one hour. This step establishes a fixed electrical resistance in the film.

The change in resistance during polymerization as a function of time for three elements of unit resistance (see box), 5.82, 28.7 and 36.1 ohms per square, respectively, is shown in Fig. 1. Taking the temperature coefficient of resistance into account, this change in resistance with time was measured with a Wheatstone bridge circuit located outside the oven.

The purpose of these conducting films being to act as a fixed resistance in an electrical system, it is important to know how to vary and hence establish different resistances. The total resistance of any film type element can be varied in four ways: (1) By changing the ratio of conductors to nonconductors (overall resistivity); (2) by altering the geometry of the circuit; (3) by varying the thickness of the



element; or (4) by revising the polymerization schedule. The ratio of conductors to non-conductors is the most economical and practical method for producing specific resistances.

A 0.005-in. film of desired unit resistance can be sprayed such that its resistance variation attributable to spraying tolerances is something less than ± 3 percent. By modifying existing commercial automatic spray equipment to achieve control over the viscosity, pressure and other properties of the material, film elements can be sprayed such that their unit resistance will vary less than two percent.

The ratio of the more conductive material to the less conductive material and the ratio of that number with respect to the resin weight can be ar-

DERIVATION OF UNIT RESISTANCE

The notation *unit resistance* or ohms per square, Φ, as used in Figs. 1 and 2, is derived as follows:

Where ρ = resistivity in ohm-in. (property of resistor)

L = length of electrical path, in.

W = width of electrical path, in.

t = film thickness, in.

Square = L/W

R = total resistance of circuit, ohms

The resistance of a conductor being directly proportional to length L, and inversely proportional to its area A (sq-in), the expression for resistance is:

$$R = \frac{L}{A} \text{ ohm-in.}$$

The area of a film type resistor is $W \times t$. All length units cancel out, leaving the resistance equal to some value in ohms. Assuming the film to be homogenous and of uniform thickness throughout, and lumping ρ/t into the term Φ for unit resistance, the total circuit resistance R becomes

$$R = \frac{L}{W} \Phi$$

Since L/W equals the number of geometrical squares, R can be written as

$$R = \Phi \text{ squares,}$$

or

$$\text{Unit resistance } (\Phi) = \frac{\text{ohms}}{\text{square}}$$

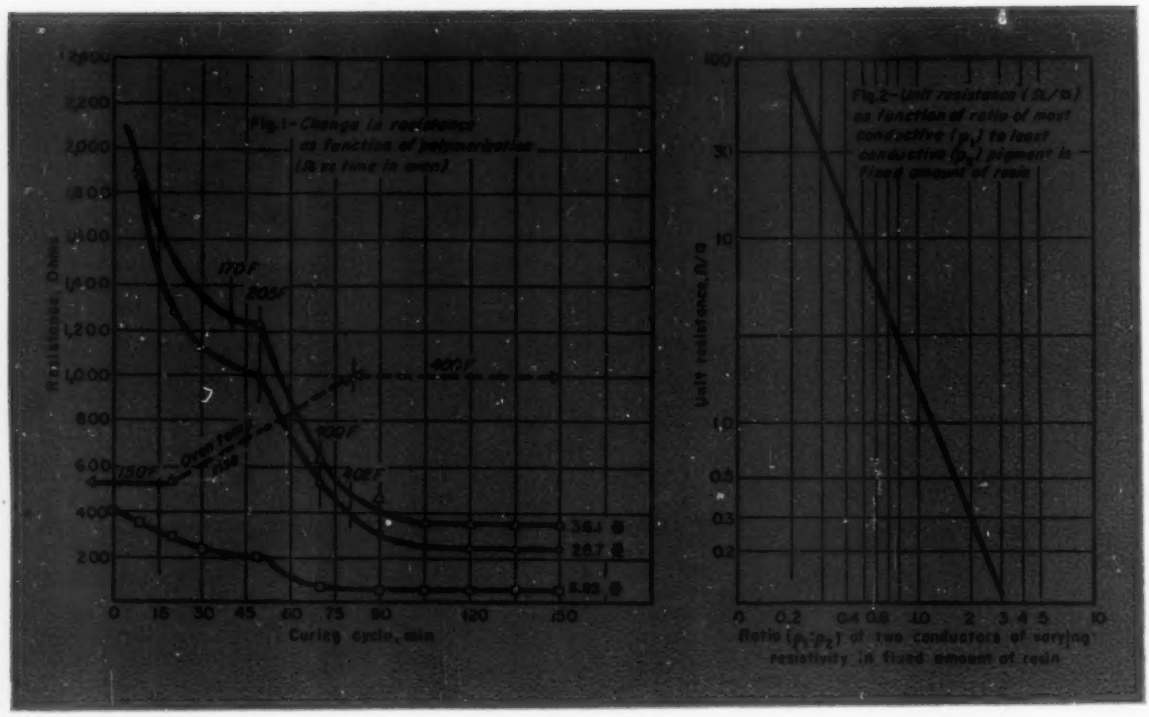


Fig. 1 – Change in resistance as function of polymerization (Ω vs time in min)
Resistance, Ohms
Curing cycle, min
110 F
205 F
400 F
200 F
150 F
Oven temp. rise
Fig. 2 – Unit resistance (Ω/□) as function of ratio of most conductive (ρ_1) to least conductive (ρ_2) pigment in fixed amount of resin
Unit resistance, Ω/□
Ratio (ρ_1:ρ_2) of two conductors of varying resistivity in fixed amount of resin

rived at empirically by studying the results produced from a carefully-planned set of formulations. As can be seen in Fig. 2, the relationship of unit resistance to the mass of conductors in a given resin weight obeys some inverse log relationship. As the more conductive constituents increase, the resistance decreases. This decrease produces large electrical changes for small increases of the highly conductive pigment. Thus, in the low ohms-per-square region, laboratory personnel compounding the mixes to the chemist's formulation must pay particular attention to the "conductor ratio". This scheme affords satisfactory quality control over the production of film type elements by establishing the final resistance of the material prior to the moment it leaves the spray nozzle.

It has been found by experience that when the resistance of the film is varied by any means other than the chemical formulation, the process becomes uneconomical, time consuming and unpredictable. Fig. 2 gives a general picture of how resistance can be changed with varying amounts and types of conductors in their non-conductor lattice.

Unlike most resistor assemblies, the temperature coefficient of resistance for these film type elements exerts little influence upon their thermal operation. This coefficient varies with the material under consideration, generally taking a positive sign for metals and a negative sign for carbons. Since the total resistance of an Electrofilm element depends upon the conductive constituents in the "mix" and the geometry of the element, a single thermal coefficient value cannot be assigned. By definition, any change in resistance accountable to the temperature coefficient must not be a permanent change. Hence, a change in resistance at upper limits of operating temperature that becomes permanent is probably caused by internal changes in the element; i.e., continued polymerization. Fig. 3 shows various temperatures coefficients of resistance for different mixes by plotting percent change in the resistance against operating temperature. It will be noted that the low-resistance materials exhibit a larger change with temperature than the higher resistance materials. This is probably due to the fact that, as the resistance decreases, the metallic content increases and takes on the temperature coefficient of the particular metal that becomes predominant.

The total resistance of a circuit can be determined by varying either the geometry of the circuit, the unit resistance of the "mixes" available, or both. To illustrate, the utility of both circuit geometry and unit resistance, take the following example. It is desired to apply a film type heating element to the inside surface of a cylinder that is 20 in. in diameter and 10 in. deep. The cylinder is to dissipate three watts per sq in. at temperatures controlled below 350 F from a 110-v a-c power supply.

The total power is

$$\pi \times 20 \times 10 \times 3 = 1,884\ w$$

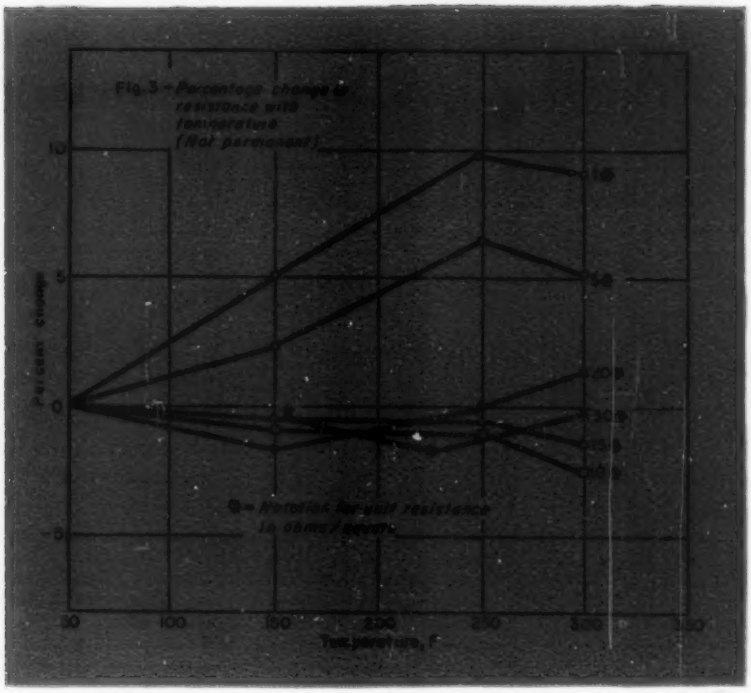
If the circuit is terminated in two 10-in. busses, the length of the electrical path becomes: πD — space for and between busses $= 60$ in. If the width of the electrical path W is 10 in., the number of squares is

$$\frac{L}{W} = \frac{60}{10} = 6 \text{ squares}$$

and the unit resistance becomes:

$$\frac{6.71}{6} = 1.12 \text{ ohms/square}$$

This explanation is sufficient for the more simple applications, but heating requirements and heat transfer conditions usually complicate the circuit. Typical of many complicating factors are: (1) Fast temperature rise (high



power output) for short lengths of time, with the power being cycled (on and off) between fixed temperature limits; and (2) fast temperature rise to a fixed temperature and maintained there with a reduced power input that equals the heat load at steady-state temperature.

The cycled condition describes an aircraft deicing system. The quick temperature rise and steady-state temperature operation describes a number of systems, such as the curing of plastic parts on metal molds, confined instrument case heaters or any system whose power for steady-state operation is considerably less than that consumed during the transient period of operation. Whether the power is reduced to zero (as in cyclic deicing) or reduced to cause steady state, the load imposed on the film-type element is the same.

As an example, take a system that will dissipate 20 *w* per sq in. for ten seconds. It will be controlled so as to open the circuit at 250 F and close again at 190 F and repeat. The heat load will be such as to establish the cooling time at a period approximating 30 seconds.

If this system were an Electrofilm element on 100 sq in. of 0.050-in. aluminum, the transient picture might look something like that shown in Fig. 4. To achieve satisfactorily the conditions just described, the element must have a coefficient of thermal expansion compatible with both the insulating material between it and the metal, and the metal itself. It must also withstand the repeated cycling without changing (permanently) its resistance. The ampere intensity and maximum cycled temperature are the determining factors in resistance stability and element life. Since the power dissipated in a single circuit, or several small circuits (n) in series, is I^2R_n and temperature is a first order function of power, the three limiting factors in the circuit are the amperage, particle resistance and maximum particle temperature reached inside the 0.005-in. thick element.

In a resinous mixture, the highest unit resistance will be the resin itself, and the lowest the metal. The metals and organic material in the compounds are excellent thermal conductors, hence they act as microscopic "thermal safety valves" to such an extent that even under transients as severe as a 30-deg temperature rise per sec, circuit continuity and surface temperatures are maintained.

Under these extreme transients, the element is subjected to considerable thermal shock. Its ability to withstand the repeated expansion and contraction is a function of the tensile strength and the homogeneity of the resin and its conductors. With careful milling of the conductors prior to the addition of resins and the correct proportions of resin to conductors, elements can be made to withstand temperature rises of 300 F in 10 sec starting at —100 Fahrenheit.

Acknowledgements: The author wishes to thank various members of the Electrofilm Research Department for their data and assistance, and acknowledges reference to National Bureau of Standards Circular 530, "Printed Circuit Techniques" during preparation of this article.

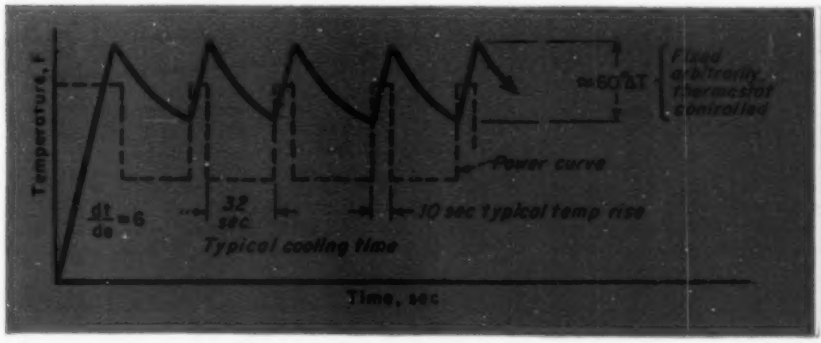


Fig. 4 — Temperature vs Time. Cycled system 20 W/in.² on 0.050 in. steel plate. Heat load forced convection during "power off" period. Area of element / Area of plate = 0.84

Mechanisms for Adjusting

Sketches show devices for both manual and automatic take-up as required by wear or stretch. Some are for installations having fixed

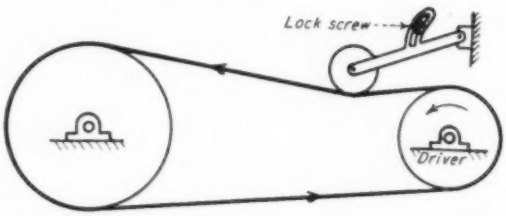


Fig. 1—Manually adjusted idler run on slack side of chain or flat belt. Useful where speed is constant, load is uniform and the tension adjustment is not critical. Can be adjusted while drive is running. Horsepower capacity depends upon the amount of tension on the belt.

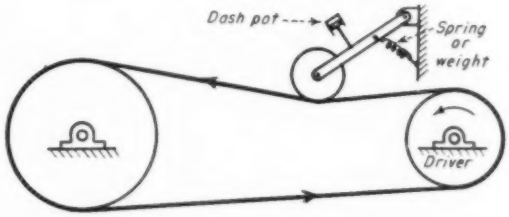


Fig. 2—Spring or weight loaded idler run on slack side of flat belt or chain provides automatic adjustment. For constant speed but either uniform or pulsating loads. Adjustments, should be made while drive is running. Horsepower capacity limited by spring or weight value.

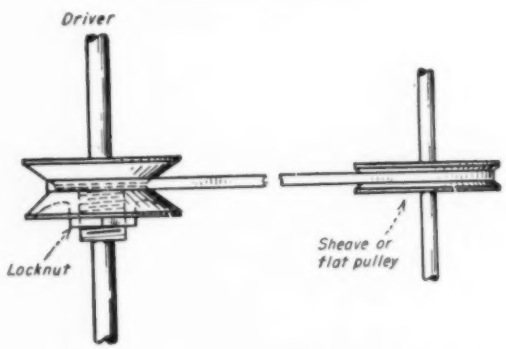


Fig. 5—Screw type split sheave for V-belts when tension adjustment is not critical. Best suited for installations with uniform loads. Running speed increases with take up. Drive must be stopped to make adjustments. Horsepower capacity depends directly upon the value of belt tension.

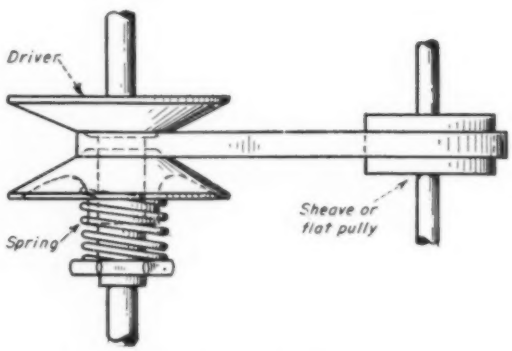


Fig. 6—Split sheave unit for automatic adjustment of V-belts. Tension on belt remains constant; speed increases with belt take up. Spring establishes maximum torque capacity of the drive. Hence, this can be used as a torque limiting or overload device.

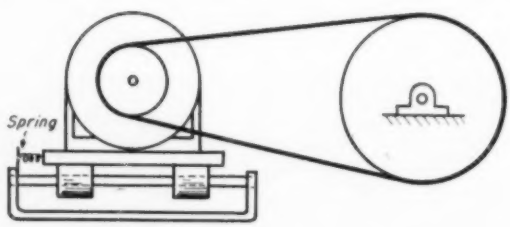


Fig. 9—Spring actuated base for automatic adjustment of uniformly loaded chain drive. With belts, it provides slipping for starting and suddenly applied torque. Can also be used to establish a safety limit for the horsepower capacity of belts.

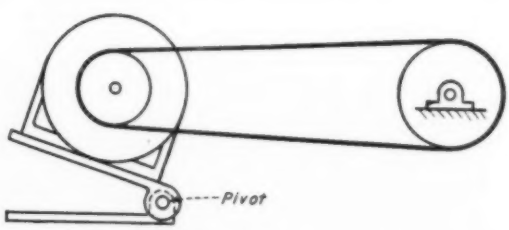


Fig. 10—Gravity actuated pivoting motor base for uniformly loaded belts or chains, only. Same safety and slipping characteristics as that of Fig. 9. Position of motor from pivot controls the proportion of motor weight effective as belt tension.

Tension of Belt Drives

JOSEPH H. GEPFERT
Reeves Pulley Company

center distances; others are of the expanding center take-up types. Many units provide for adjustment of speed as well as tension.

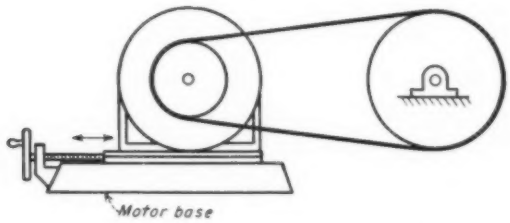


Fig. 3—Screw-base type unit provides normal tension control of belt or chain drive for motors. Wide range of adjustments can be made either while unit is running or stopped. With split sheaves, this device can be used to control speed as well as tension.

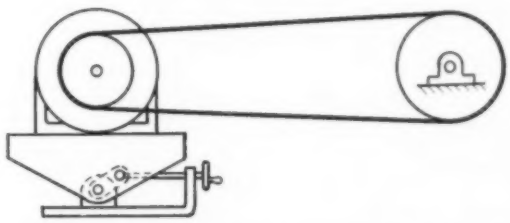


Fig. 4—Pivoting screw base for normal adjustment of motor drive tension. Like that of Fig. 7, this design can be adjusted either while running or stopped and will provide speed adjustment when used with split sheaves. Easier to adjust than the previously mentioned design.

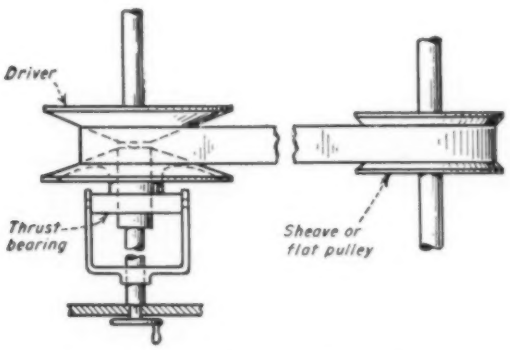


Fig. 7—Another manually adjusted screw type split sheave for V-belts. However, this unit can be adjusted while the drive is running. Other characteristics similar to those of Fig. 6. Like Fig. 6, centers can be changed to maintain speed or vary speed within limits of split sheave.

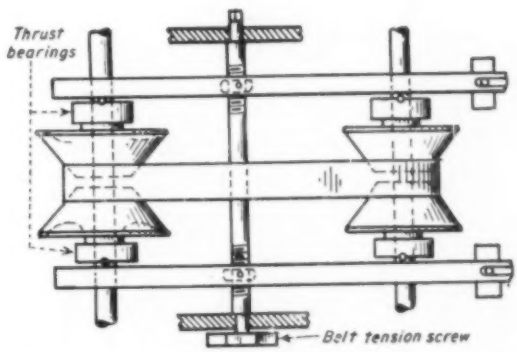


Fig. 8—Special split sheaves for accurate tension and speed control of V-belts or chains. Applicable to parallel shafts on short center distances. Manually adjusted with belt tension screw. No change in speed with changes in tension.

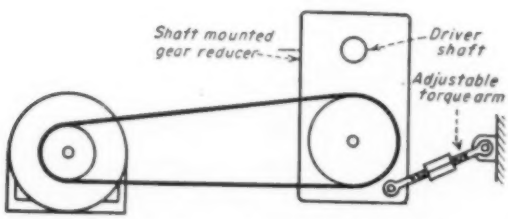


Fig. 11—Torque arm adjustment for use with shaft mounted speed reducer. Can be used as belt or chain take up for normal wear and stretch within the swing radius of the reducer. Also useful for changing speed while running when spring type split sheave is used on motor.

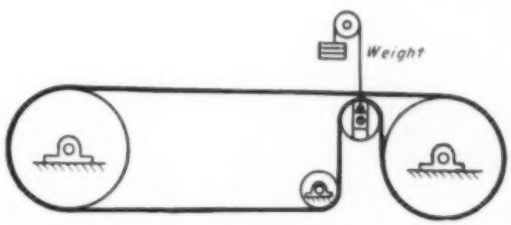


Fig. 12—Wrapping type automatic take for flat and wire belts of any width. Used for maximum driving capacity. Size of weight determines tension put on belt. Maximum value should be established to protect belt from being overloaded.

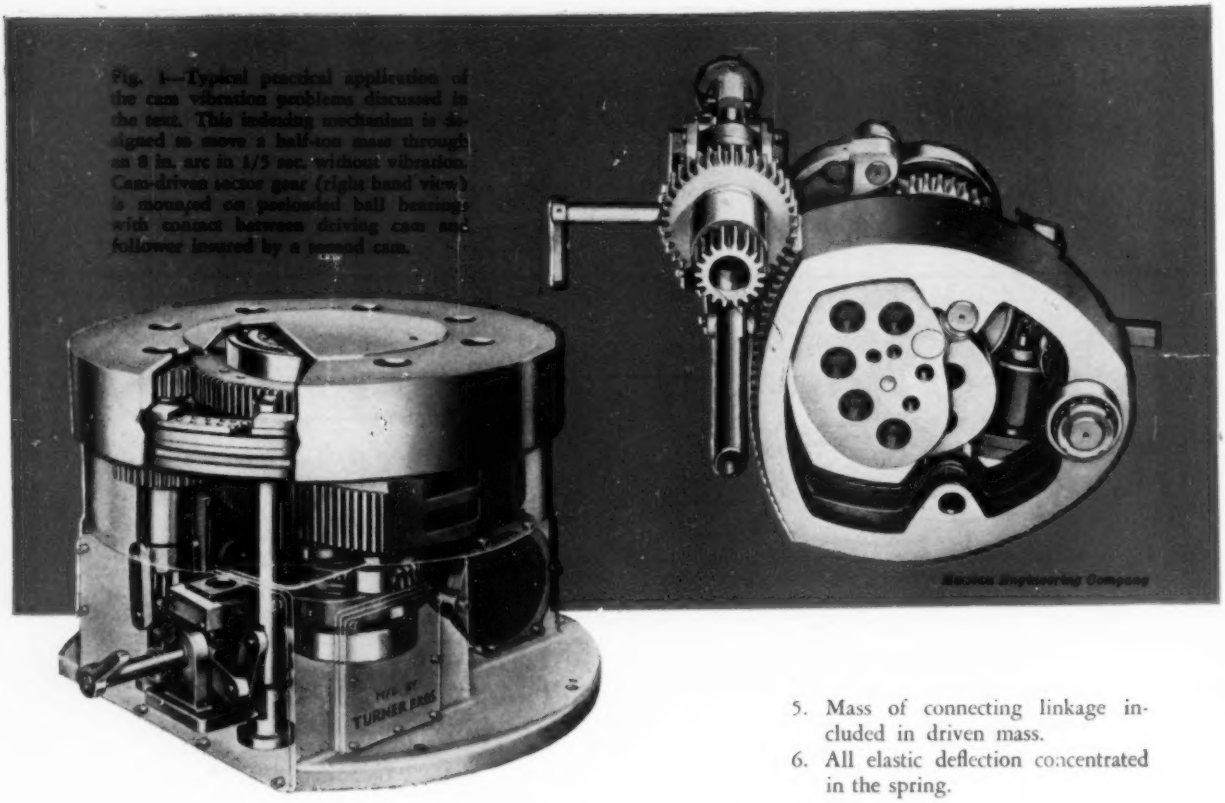


Fig. 1—Typical practical application of the cam vibration problems discussed in the text. This indexing mechanism is designed to move a half-ton mass through an 8 in. arc in 1/5 sec. without vibration. Cam-driven sector gear (right hand view) is mounted on preloaded ball bearings with contact between driving cam and follower insured by a second cam.

CAM DYNAMICS

DOUGLAS G. ANDERSON
McIntosh Stamping Corp.

VIBRATION in cam-actuated mechanisms is a function of the choice of cam-form. Since this vibration may be the chief contributor to the dynamic loading of the mechanism, this realization has aroused new interest in finding forms which cause low loading.

The system considered is shown in Fig. 2. A mass, M, is connected to the follower of a cam by a light elastic linkage, represented by a spring. The follower and the mass are both assumed to be at rest until the initial point of rise reaches the follower. Then, the follower is moved distance Y, in time T, after which it is again at rest.

In this analysis, the following assumptions are made:

1. No loss of contact between members of the mechanism.
2. Spring rate, k, not dependent on position of cam-follower.
3. No vibration transmitted from driving side to driven side of the cam.
4. All friction is negligible.
5. Mass of connecting linkage included in driven mass.
6. All elastic deflection concentrated in the spring.

The Ideal Cam

The motion of the mass which would cause the least dynamic load on the spring is the motion imparted to a rigid follower by a parabolic cam. In the first half of the time the mass would be accelerated at a constant rate. During the second half, it would be decelerated at the same constant rate, reaching zero velocity at the top of the rise.

Unfortunately, the mathematically perfect cam which would impart this motion to the driven mass has no practical value. Since the spring must deflect to transmit a force to the mass, an instantaneous change in acceleration of the mass requires an instantaneous change in position of the follower, which is physically impossible. Therefore, the motion described is an unattainable ideal.

The problem, then, is to discover and recognize practical forms which approach the ideal. The ideal cam will be used as a basis for comparison of other cam-forms.

Character of the Motion of the Driven Mass

Attention will be focussed on the motion of the driven mass. If the

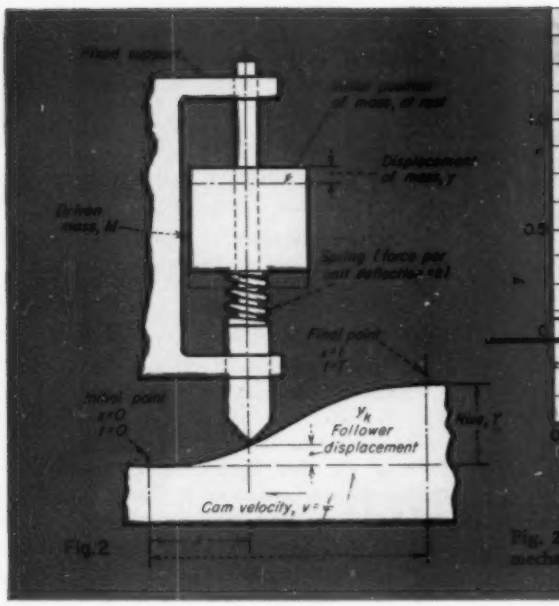

Driven mass, M
Displacement of mass, y
Spring (force per unit deflection = c)
Final point x = l, y = Y
Initial point x = 0, y = 0
y_K
Follower displacement
Rise, Y
Cam velocity, v = ẋ

Fig. 2—Essential elements of the cam and the driven mechanism which is used to study cam vibrations.

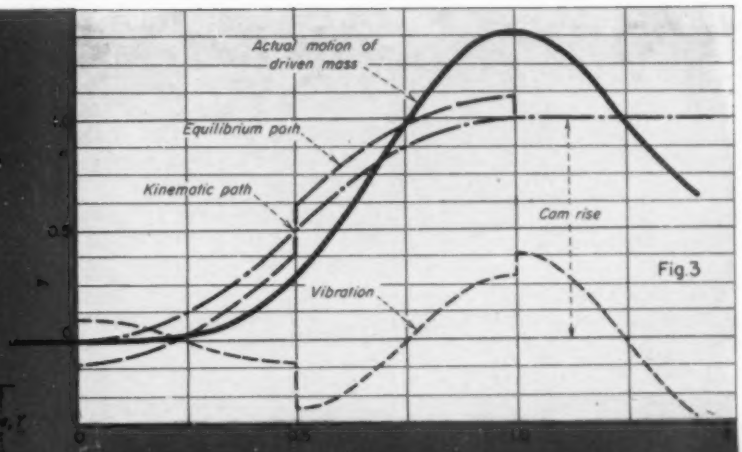


Fig. 3—The motion of a mass driven by a parabolic cam, when the time for the rise equals the period of vibration.

motion is known, the acceleration can be found, and so, also, the force transmitted by the spring.

If the displacement is plotted against time, the motion will appear as a curve. For convenience, the cam of Fig. 2 is represented as having a uniform velocity to the left. Thus one may plot the displacement against x instead of t, and still obtain the motion as a curve. This is called the path of motion. It is convenient to use x as the independent variable, rather than t, when considering the effects of a change in speed of operation.

Because the spring must deflect to transmit force, the motion of the mass will differ from the motion which would occur if the spring were rigid. The latter will be called the *kinematic motion*, which is identical to the motion of the follower. Also, when friction is negligible, the whole force exerted by the spring causes acceleration of the mass. Thus

$$F = k(y_k - y) = Ma = M\frac{d^2y}{dt^2}$$

$$= M\frac{d^2x}{dt^2}\frac{d^2y}{dx^2} = Mv^2\frac{d^2y}{dx^2}$$

(See Fig. 1 for definitions.) Using the notation y'' for $\frac{d^2y}{dx^2}$ and letting

$$\frac{k}{M} = q^2,$$

this equation can be put in the form

$$y + \left(\frac{v}{q}\right)^2 y'' = y_K$$

The ratio v/q will be called the speed ratio, and denoted by r. Then

$$y + r^2y'' = y_K \qquad (1)$$

This fundamental equation must be satisfied by every possible motion of the mass, including vibration, and at any operating speed.

Natural Vibration

If y_K is a constant, the solution of Eq (1) takes the form

$$y = A\sin\frac{x}{r} + B\cos\frac{x}{r} + y_K,$$

in which A and B are any constants. This represents free vibration about the fixed point y_K, which is the point of equilibrium.

Denoting the displacement from the point of equilibrium, due to vibration, by y_n, then

$$y_n = A\sin\frac{x}{r} + B\cos\frac{x}{r}. \qquad (2)$$

Since $\frac{x}{r} = qt$, this kind of motion is independent of v, and goes through a complete cycle in the time $T_n = \frac{2\pi}{q}$, the period of vibration. The maximum which y_n attains in each cycle of vibration, known as the amplitude, has a value

$$\overline{y_n} = \sqrt{A^2 + B^2}$$

The Equilibrium Motion

When y_K is not a constant, the position of the point of equilibrium is a function of y_K and r, which will be denoted by y_e, and which must satisfy Eq (1). Its form will be considered later. The general solution of Eq (1) is

$$y = y_n + y_e. \qquad (3)$$

Thus the actual motion is the sum of two parts, the vibration and the equilibrium motion.

At low speeds, the equilibrium motion differs little from the kinematic motion, except that its path will, in general, include small abrupt changes in height or slope, corresponding to discontinuities in displacement or velocity, respectively. These discontinuities may be expected wherever the function defining the cam-form changes, and therefore, especially at the initial and final points of the rise.

Compensated Cams

It is mathematically possible to choose a smooth, vibration-free path for the mass, and then to design the cam to drive the mass along that path at any one speed. When this is done for a speed other than zero, the cam is said to be compensated. The operating speed for which the cam is compensated is called the design speed. The corresponding value of r is r_D. The path of the mass at this

speed is the curve y_D.

Substituting y_D and r_D in Eq (1),

$$y_K = y_D + r^2_D\, y''_D. \qquad (4)$$

Thus, when y_D is chosen at will, y_K is a function of y_D and r_D. At design speed there is no vibration. At speeds less than design speed, vibration is induced, but the dynamic loading is less than at design speed, unless r_D is very high. See Eq (11).

Compensation is impractical for the parabolic and harmonic forms, among others, because it requires abrupt steps in the cam which cannot be negotiated by the cam follower. The compensated parabolic cam is the theoretical ideal cam discussed earlier. To avoid discontinuities in y_K, y''_D must be continuous from $x = 0$ to $x = 1$, and zero at these end points.

When y_K is chosen arbitrarily, there is, in general, no speed other than zero at which the equilibrium path is smooth. Then, r_D is zero, and $y_D = y_K$.

The Equilibrium Path

Letting $y = y_e$ in Eq (1), and using the value of y given in Eq (4), then,

$$y_e = y_D + r_D{}^2\, y''_D - r^2\, y''e \qquad (5)$$

But y''_e is unknown. Differentiating Eq (5) twice gives y''_e, which, substituted back into this equation, yields

$$y_e = y_D + r_D{}^2\, y''_D - r^2\,(y''_D + r_D{}^2\, y_D{}^{IV} - r^2\, y_e{}^{IV}),$$

in which y'^{v}_e remains unknown. Continued repetition of this step leads to

$$y_e = y_D + \left[\left(\frac{r_D}{r}\right)^2 - 1\right] \left[(r^2 y''_D - r^4\, y_D{}^{IV} + r)^6 y^{VI} - \dots\right] \qquad (6)$$

This is free of unknowns. If y_D is algebraic, the series terminates. If the series does not terminate, it is valid in its interval of convergence.

Eq (6) is a general expression for the equilibrium path. When r is zero, it reduces to y_K. When r is r_D, it reduces to y_D. Note that it involves all the even-order derivatives of y_D. All the odd-order derivatives are involved in the first derivative of y_e, which is found by differentiating Eq (6). Multiplied by r, this is

$$r y'_e = r y'_D + \left[\left(\frac{r_D}{r}\right)^2 - 1\right] \left[(r^3 y_D''' - r^5 y_D{}^{V} + r^7 y_D{}^{VII} - \dots)\cdot\right] \qquad (6')$$

The Cause of Vibration

Vibration is introduced at each discontinuity in the equilibrium displacement or velocity. In the absence of friction, its amplitude remains constant between discontinuities, but changes at each discontinuity. The parabolic cam will be used to illustrate. The equation for the first half of the rise is $y_K = 2Yx^2$. The corresponding equilibrium path is $y_e = y_K - 4Yr^2$. Note that this value satisfies Eq. (1). For the second half of the rise, $y_K = Y - 2Y(1\text{-}x)^2$, and $y_e = y_K + 4Yr^2$. Thus the equilibrium path for each half of the cam is parallel to the kinematic path, but displaced from it by the deflection of the spring required to transmit the force for the acceleration. During the first half of the rise, the spring would have to be compressed, and the equilibrium path is below the kinematic path. During the second half of the rise the spring would have to be extended, and the equilibrium path is above the kinematic path.

This is illustrated in Fig. 3. The difference between the kinematic and equilibrium paths is dependent on the speed. It is large in this chart because the speed chosen is extremely high, such that $T = T_n$.

Prior to reaching the initial point, the mass is at rest, and the kinematic and equilibrium positions coincide with the actual position. At the initial point the mass suddenly finds itself above the equilibrium position. It starts to vibrate about that position, as any elastically suspended mass vibrates about its position of equilibrium. The sum of the motion of the point of equilibrium and the vibration about that point is the actual motion of the mass, shown in Fig. 3 as a solid-line curve. The vibration alone is shown as a short-dash-line curve.

At each discontinuity in the equilibrium path, the vibration changes in such a way as to preserve the smoothness of the actual path. This smoothness is a physical necessity, since an infinite force would be required to instantaneously change the position or velocity of the mass. That is, y and y' cannot change abruptly. But y_e *or* y'_e, or both, will contain discontinuities unless r equals zero or r_D. Such discontinuities can be expected wherever the function specifying y_D changes form and particularly at the initial and final points of the rise. For example, let b be the value of x at such a discontinuity and let $(\Delta y_e)_b$ represent the discontinuity in y_e at b. Using this notation, any identity may be replaced by the corresponding discontinuity equation. Then, from Eq. (3),

$$(\Delta y)_b = (\Delta y_n)_b + (\Delta y_e)_b$$

But $(\Delta y)_b$ is zero, since y is everywhere continuous. Therefore

$$(\Delta y_n)_b = -(\Delta y_e)_b \qquad (7)$$

Similarly, differentiating Eq (3), and applying the above steps,

$$(\Delta y'_n)_b = -(\Delta y'_e)_b. \qquad (7')$$

It is now possible to evaluate the vibration introduced at any point of discontinuity.

For example, consider the initial point of the rise. By hypothesis the mass is at rest until $x = 0$. Then A and B of Eq (2) are zero, and y_e and all its derivatives are zero. At $x = 0$, y_e and y'_e assume values y_{eo} and y'_{eo}. Combining Eqs. (2) and (7),

$$(y_n)_o = (\Delta y_n)_o = -(\Delta y_e)_o = -(y_e)_o = A_o \sin 0 + B_o \cos 0 = B_o.$$

Or $B_o = -(y_e)_o$.

Differentiating Eq (2), and multiplying by r,

$$r\, y'_n = A \cos\left(\frac{x}{r}\right) - B \sin\left(\frac{x}{r}\right) \qquad (2')$$

From Eqs. (2′) and (7′),

$$A_o = -r\,(y'_e)_o.$$

The amplitude of vibration, from $x = 0$ to the next point at which a discontinuity occurs, is then

$$(\overline{y_n})_o = \sqrt{y_{eo}{}^2 + (r\, y'_{eo})^2} \qquad (8)$$

This can be evaluated by use of Eqs. (6) and (6′).

Influence of Speed

The speed of operation affects the amount of vibration in two ways. First, it affects the difference between the kinematic and equilibrium paths. Second, it determines the time elapsed between discontinuities.

If the cam of Fig. 2 were operated at half the speed, so that $T = 2T_n$, each discontinuity would have one fourth its previous value. This effect alone would reduce the amplitude of vibration to one fourth its previous value. But also, one full cycle of vibration would occur during the first half of the rise, and at the midpoint the actual position would coincide with the kinematic position. Then the discontinuity of the equilibrium position at the midpoint would not in-

crease the vibration displacement, but would merely reverse its sign. At the final point, the actual position would again coincide with the kinematic position, and the effect of the final discontinuity would be to reduce the vibration to zero.

A similar detailed analysis may be made for any cam form at any speed. But when T is a large multiple of T_n, only a small percentage change in T is required to reach a value at which each discontinuity in the equilibrium position or velocity has the fullest effect in increasing the amplitude of vibration. Therefore, at all but the highest speeds, one need only consider the effect of speed on the magnitude of these discontinuities, and may assume that the effect of each discontinuity is to reinforce existing vibration to the fullest extent. This assumption leads to

$$(\overline{\Delta y_n})_b = \sqrt{(\Delta y_e^2)_b + r^2 (\Delta y'^2_e)_b} \qquad (9)$$

When y_D and all its derivatives are continuous from $x = 0$ to $x = 1$, and y_D is symmetrical about the midpoint, the amplitude is constant throughout the rise, and doubles at the final point.

Stress, Acceleration and Deflection

The curves in Fig. 3 illustrate how abrupt changes in the equilibrium path induce vibration. They can also be interpreted in terms of stress in the follower mechanism.

At any instant, the difference between the kinematic position and the actual position represents a compression or extension of the spring. Since the spring is elastic, its deflection is proportional to the stresses within it, and to the force transmitted by it. But this force accelerates the driven mass. Thus the acceleration and the stress may both be measured by the deflection of the spring. Deflection is taken as positive when the spring is compressed.

For ordinary speeds, the deflections are so small compared to the total rise of the cam that a diagram such as Fig. 3 is impractical. This difficulty is avoided by omitting the kinematic path, and plotting only the vibrational and equilibrium deflections. Fig. 4(A) is such a diagram, for the conditions of Fig. 3. Since the deflection is positive when the acceleration is positive, the vibrational deflection in Fig. 4(A) appears reversed in sign from the vibrational displacement of the previous figure.

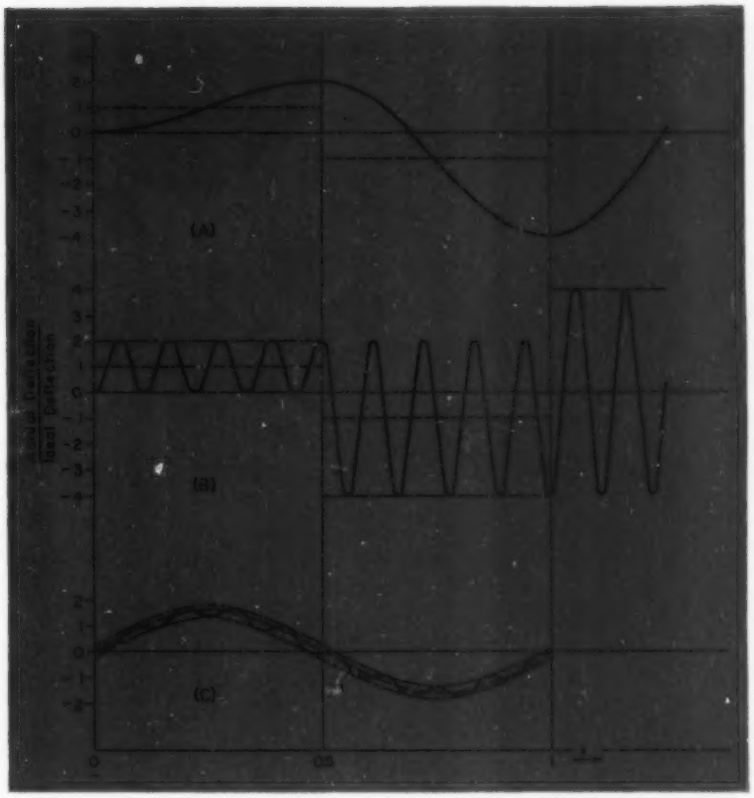


Fig. 4—The actual deflection in terms of the ideal deflection, for conditions as follows: (A) Parabolic cam, when $T = T_n$. (Same case as Fig. 3.) (B) Parabolic cam, where $T = 9\ T_n$ (C) Cycloidal cam, where $T = 9\ T_n$. In each case the dotted line represents the equilibrium deflection, and solid line the actual deflection which is the equilibrium deflection altered by vibration. The dot-dash lines of (B) and (C) are the total deflections, whose maximum equal the maximum actual deflection when T_n is small.

A similar diagram, Fig. 4(B), represents the condition $T = 9T_n$ for the same parabolic cam, but plotted to a vertical scale 81 times as great. Fig. 4(C) is a diagram for a cycloidal cam with the same rise, operating at the same speed as the cam of 4(B), and plotted to the same scale.

Fig. 4(B) and (C) include curves drawn in dot-dash lines, parallel to the equilibrium curves and tangent to the actual deflection curves. These curves are artificial but convenient, and will be said to represent *total* deflection. It is evident that the actual deflection can never exceed the total deflection, and that at low speeds the maximum total deflection is almost equal to the peak value of the actual deflection. This approximation is good even at high speeds for cam forms with low vibrational characteristics.

Acceleration and Deflection Equations

The acceleration of the mass is

$$a = \frac{d^2y}{dt^2} = v^2 y''.$$

Differentiating Eq (3) twice, and substituting in the above,

$$a = v^2(y''_n + y''_e).$$

But by differentiating Eq (2) twice, it can be shown that

$$y_n'' = -\frac{1}{r^2}\, y_n = -\left(\frac{q}{v}\right)^2 y_n$$

Substituting this in the above,

$$\frac{a}{q^2} = r^2 y_e'' - y_n$$

Derived from the basic acceleration equation, this expression is actually the deflection of the spring. Replacing $-y_n$ by its maximum, $\overline{y_n}$, and replacing y''_e by its maximum, $\overline{y''_e}$, it is possible to obtain the maximum *total deflection*. Thus,

$$\frac{\overline{a_T}}{q^2} = r^2 \overline{y_e''} + \overline{y_n} \qquad (10)$$

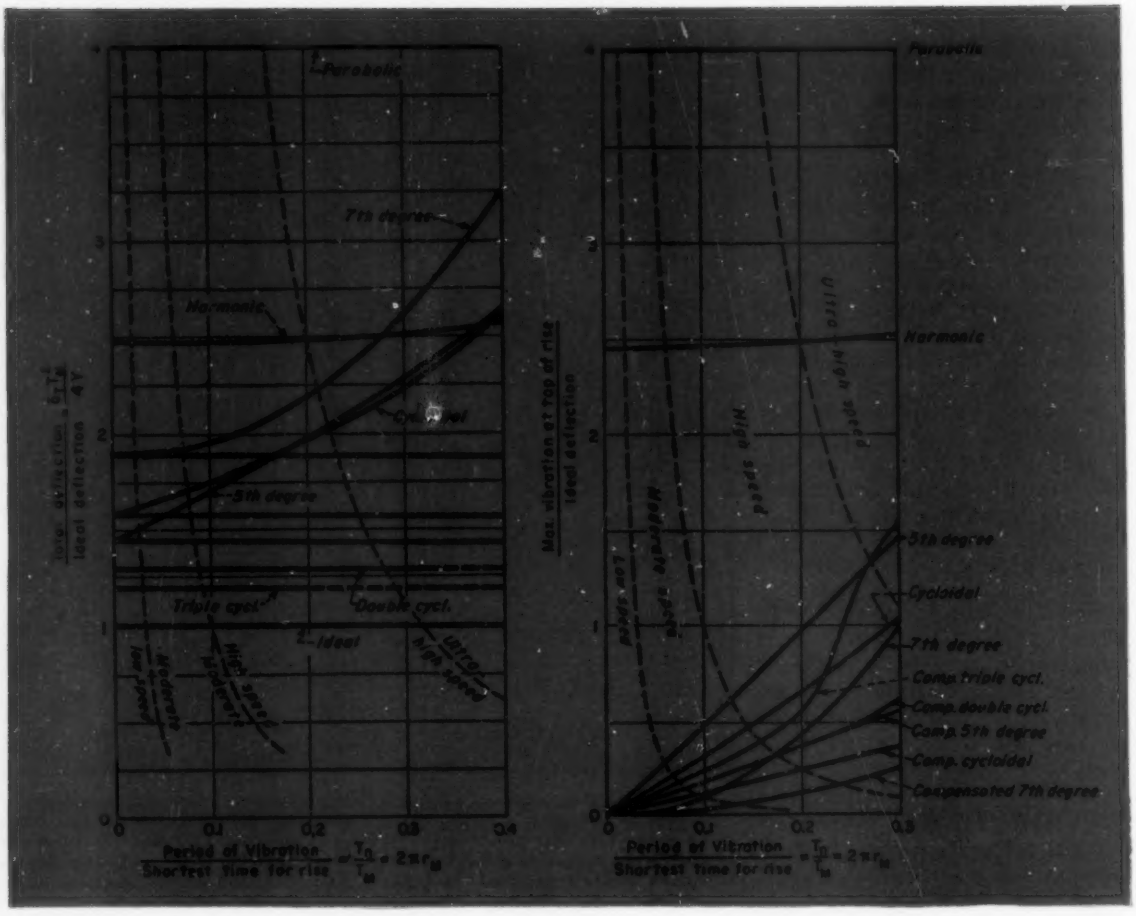


Fig. 5—Deflection characteristics of various cams, as a function of operating speed. Compensated cams have flat characteristics, because it is assumed that they are compensated for the maximum operating speed. Curves for the multiple-cycloidal compensated cams are dotted at the higher speeds. For these speeds, there are regions near $T_n/T = 1/5$ and $T_n/T = 1/3$, in which the maximum deflection exceeds design speed maximum deflection.

Fig. 6—The vibration characteristics of various cams, as a function of operating speed. The dotted-line curves dividing the speed ranges may be taken to represent the deflection introduced by a local error in cam-form of 1/10,000, 1/1,000, or 1/100 of the total rise. Thus a low vibration characteristic is of little significance at low speed, and conversely, extreme precision of manufacture serves little purpose at very high speed.

Differentiating Eq (6′) and multiplying by r,

$$r^2 y_e'' = r^2 y''_D + \left[\left(\frac{r_D}{r}\right)^5 - 1\right]$$

$$(r^4 y^{IV}_D - r^6 y_D{}^{VI} + \ldots). \qquad (6'')$$

The extreme value of this expression, with respect to x, without regard to sign, is $r^2\,\overline{y''}_e$.

When $r_D = 0$, both $r^2 y_e''$ and y, in general, increase indefinitely with r. But when r_D is not zero, there is a speed between zero and r_D at which $\overline{y_n}$ reaches a maximum. This speed is a function of r_D, obtainable by setting the derivative of Eq (8) with respect to r equal to zero and solving for r. Also, when r_D is not zero, vibration vanishes at r_D, and Eq. 10 has the simple form

$$\frac{\overline{a_r}}{q^2} = r_D{}^3\,\overline{y''}_D$$

This is the greatest deflection in the range from $r = 0$ to $r = r_D$ if r_D is not too large. The limiting value is at least as large as the appropriate root of the following equation in r_D.

$$\frac{d}{dr}(r^2\,\overline{y''}_e + \overline{y_n}) = 0, \text{ when } r = r_D. \qquad (11)$$

This equation yields values near $\frac{1}{2}$ for all compensated cams discussed, except the multiple-cycloidal.

Speed Classification

It is convenient to classify cam applications according to speed, such as low, moderate, or high. A rational criterion for such classification is the ratio of the total deflection to the rise of the cam. There is room for much difference of opinion as to proper limits for each speed range, but for general purposes the following are suggested:

1. *Low Speed.* One for which the total deflection does not exceed 1/10,000th of the total rise. The errors in manufacture can be expected to be more important than the characteristics of the cam-form in producing vibration, unless extreme care is used in eliminating all such errors.

2. *Moderate Speed.* Total deflection between 1/10,000 and 1/1,000 of the total rise. In this range the

form of the equilibrium deflection curve becomes significant for cams made with ordinary care.

3. *High Speed.* Total deflection between 1/1,000 and 1/100 of the total rise. In this range it is always important to use a good cam-form if vibration or dynamic loads are to be kept low.

4. *Ultra-Speed.* Total deflection exceeds 1/100 of the total rise. Such applications are rare, except for those in which the operating speed is constant, or in which high deflection is desirable and special means are provided for absorbing vibration. In this range, actual deflection is required for a valid analysis; the total deflection is not a reliable approximation.

Effect of Imperfections

The imperfections of form by which an actual cam differs from the theoretical shape include distortions, roughness, waviness and mistakes.

Distortion has many causes, but differs from the other types of error in that it varies in a continuous manner throughout the form. Therefore, it introduces no vibration, and unless it is extremely large, it will cause no significant change in the total deflection.

Roughness is a random distribution of many small errors, which cause small abrupt changes in the equilibrium path. Since they are random, any one change is as likely to decrease previously existed vibration as to increase it, and the energy fed into the follower mechanism by this source is absorbed by damping at a very low level of vibration.

Waviness is a periodic, more or less uniform distribution of small errors, such as might result from using too great a feed in generating the form with a milling cutter. Because they are periodic, the effects of successive errors will tend to reinforce one another at certain speeds. Thus waviness can cause much greater vibration than roughness of the same magnitude.

Mistakes, like distortion, can be large or small. They differ from distortion in that they are local in character. Thus one incorrect setting of a milling cutter in generating a templet point-by-point, or cutting too deeply in filing the resulting templet smooth, can cause a local deviation from the desired form. Even though the resulting cam appears beautifully smooth to the eye or touch, this type of error can cause heavy vibration by introducing large abrupt changes in the equilibrium path.

The above discussion indicates that the effects of a given error are independent of the specified cam-form. The importance of a given error depends on its size in relation to the total deflection, which is primarily a function of the operating speed. The upper limits of the low, moderate, and high speed ranges might well be taken as the magnitudes of error expected from precise, average, and crude manufacture. An error of 0.010 in., unimportant in a mechanism whose design deflection is one inch, is intolerable

CHARACTERISTICS OF DIFFERENT CAM FORMS

NAME	CAM-FORM FORMULA	MAX. VIBRATION AT TOP OF RISE	MAX. TOTAL DEFLECTION
Parabolic	$\frac{y}{Y} = 2X^2$, when $X \le \frac{1}{2}$; or $1-2(1-X)^2$, when $X > \frac{1}{2}$	$16 r_0^2 Y$	$16 r_0^2 Y$
Harmonic	$\frac{y}{Y} = \frac{1}{2}(1 - \cos \pi X)$	$\frac{(\pi r_0)^2}{1-(\pi r_0)^2} Y$	$\frac{(\pi r_0)^2}{1-(\pi r_0)^2} Y$
Cycloidal	$\frac{y}{Y} = X - \frac{1}{2\pi} \sin 2\pi X$	$\frac{Y}{\pi^2} \cdot \frac{(2\pi r_0)^2}{1-(2\pi r_0)^2}$	$\frac{Y}{2\pi} \cdot \frac{(2\pi r_0)^2}{1-2\pi r_0}$
Compensated Cycloidal	$\frac{y}{Y} = X - \frac{1-(2\pi r_0)^2}{2\pi} \sin 2\pi X$	$.01224\,(2\pi r_0)^5 Y$, approx., when $2\pi r_0 < \frac{1}{2}$	$\frac{Y}{2\pi} \cdot (2\pi r_0)^5$
5th Degree	$\frac{y}{Y} = \frac{1}{2} - \frac{15}{8} Z - 8Z^3 + 6Z^5$, where $Z = X - \frac{1}{2}$	$\frac{\pi}{2} r_0^2 = 20 r_0^3 (1 + 12 r_0^2 + 144 r_0^4 + \cdots) Y$	$240 r_0^3 (\frac{1}{12} + 2 r_0^2) \frac{1}{2} Y + \frac{1}{2} \pi r_0$
Compensated 5th Degree	$\frac{y}{Y} = \frac{1}{2} - (\frac{15}{8} - 30 r_0^2) Z - (5 - 120 r_0^2) Z^3 + 6Z^5$	$.0436 r_0^3 (1 - \frac{4}{3} r_0^2)(1 + \frac{10}{3} r_0^2) Y$, approx., when $2\pi r_0 < \frac{1}{3}$	$\frac{10}{27}\sqrt{3}\, r_0^2 Y$
7th Degree	$\frac{y}{Y} = \frac{1}{2} - \frac{35}{16} Z - \frac{35}{4} Z^3 + 21 Z^5 - 20 Z^7$	$1680 r_0^4 (1 - 60 r_0^2)^{\frac{1}{2}} + 144 r_0^2 - 10 r_0^2)^{\frac{1}{2}}$ $= \frac{\pi}{2} r_0$	$11.731 (\frac{1}{12} r_0^2 + 32 r_0^4 + 1796 r_0^6) Y + \frac{1}{2} \pi r_0$, approximately
Compensated 7th Degree	$\frac{y}{Y} = \frac{1}{2} - (\frac{35}{16} - \frac{105}{2} r_0^2) Z - (\frac{35}{4} - 420 r_0^2) Z^3 + (21 - 840 r_0^2) Z^5 - 20 Z^7$	$420 r_0^4 (1 + 6 r_0^2) Y$, approximately	$\frac{84}{25}\sqrt{5}\, r_0^2 Y$
Compensated Double Cycloidal	$\frac{y}{Y} = X - .9404 \frac{1-(2\pi r_0)^2}{2\pi} \sin 2\pi X - .0596 \frac{1-(6\pi r_0)^2}{6\pi} \sin 6\pi X$; $\frac{y}{Y}$ max. $= .181\,(2\pi r_0)^5$, approx., when $2\pi r_0 < \frac{1}{6}$		$5(3_0^5 Y$, valid at least when $2\pi r_0 < \frac{1}{3}$
Compensated Triple Cycloidal	$\frac{y}{Y} = X - .9097 \frac{1-(2\pi r_0)^2}{2\pi} \sin 2\pi X - .0798 \frac{1-(6\pi r_0)^2}{6\pi} \sin 6\pi X - .0149 \frac{1-(10\pi r_0)^2}{10\pi} \sin 10\pi X$; $\frac{y}{Y}$ max. $= .24\,(2\pi r_0)^7$, approx., when $2\pi r_0 < \frac{1}{10}$		$4.78 r_0^5 Y$, valid at least when $2\pi r_0 < \frac{1}{6}$

in a mechanism designed to deflect only 0.001 inch.

Comparison of Selected Cam Forms

In Fig. 5, the maximum total deflection is given as a function of the maximum speed, for several cam-forms.

The residual vibration, that is, the vibration existing just after reaching the final point of the rise, for the same cams is compared in Fig. 6. For the compensated forms the maximum speed is the design speed. The vibration plotted is the maximum in the range from zero to design speed. The speed at which this maximum vibration occurs is not indicated.

The proposed boundaries for the different speed ranges are indicated in Figs. 5 and 6 by dotted lines. The equation for each cam-form, and for each curve is given in the Table of Characteristics. Study of these data leads to the following conclusions:

1. The parabolic cam, though it has the lowest possible equilibrium deflection, is a poor choice at any speed.

2. The harmonic cam is also poor, though never as bad as the parabolic.

3. The cycloidal cam is good over the whole range of speeds, both for low vibration and low deflection.

4. Compensation offers advantages for any high-speed application. The compensated cycloidal cam has unusual advantages in that it is no more difficult to compute or generate than the uncompensated type.

5. The fifth-degree cam is similar to the cycloidal in its characteristics, but is more difficult to compute or to generate mechanically.

6. The double-cyclodal and triple-cyclodal forms are original developments. They resulted from a research for forms whose deflection characteristics more nearly approach the ideal. It is assumed that any application will be in compensated form. The gain in deflection characteristics involves a sacrifice in vibrational characteristics, as compared to simpler compensated forms. For constant-speed applications, the triple-cycloidal is best.

7. The seventh-degree cam is included here as the most simply defined algebraic type for which the design displacement, velocity, acceleration and first derivative of acceleration are all everywhere continuous. This condition gives two advantages to the compensated cam. First, its residual vibration is the lowest of any cam considered. Second, the compensated cam is smooth, which is not true of any other form considered. The total deflection unfortunately is higher than that of any other compensated form. By using equations of higher degree it is unquestionably possible to find forms with the advantages of the seventh-degree cam and also with low total deflection.

It appears that when cams of greater practical worth are found, their advantages will be evident only in the high and ultra-high speed ranges. At lower speeds, errors in manufacture will usually offset the theoretical advantage of any form better than the compensated cycloidal.

Calibrating Multimillion Pound Testing Machines

DEVELOPMENT of load calibrating devices of unusual size and capacity by the National Bureau of Standards will permit the standardization of the largest materials testing machines in existence. The four NBS 3-million-pound-capacity compression dynamometers recently completed can accurately measure forces up to 12,000,000 pounds.

Prior to development of these dynamometers, which make use of attached wire-resistance strain gages as a part of their load-indicating systems, the highest load that could be accurately measured was approximately 2½ million pounds. To do this required the simultaneous use of a considerable number of calibration devices (such as proving rings) of 200,000 and 300,000 pound capacity. It is estimated that a testing machine can now be calibrated to 10,000,000 pounds by means of the new dynamometers in about one-fourth the time and at about half the cost formerly required to calibrate it to 2,500,000 pounds.

High-capacity testing machines are increasing in importance in engineering research programs. One reason is that mechanical properties of materials as determined from tests of small specimens do not always give a complete picture of what may be expected from a structure fabricated from large rolled sections or forgings. The soundest approach is to apply actual service loads to full scale specimens which have been fabricated from the same materials that will go into the real structure.

Still another reason for emphasis on testing full-scale units is the fact that failure of such structures in service is sometimes caused by points of high stress rather than lack of strength in the material. These critical stress areas are caused by designs which include sharp angles or notches introduced into the structure during machining or welding. Points of high stress may operate in various ways. It is impossible to reproduce, in a small scale model, the effects of welding stresses or machining notches.

For results obtained in research of this type to be considered reliable and compared with results from different laboratories, it is necessary to control the accuracy of the testing machines. It is a simple matter to calibrate smaller machines by use of proving rings, but the calibration of the larger machines presents definite obstacles. Proving rings are made in capacities up to 300,000 pounds and although it is possible to calibrate above this limit by loading several rings simultaneously (the method has been employed up to about 2,600,000 pounds) the process is costly and difficult.

In 1940 the possibility of utilizing a uniformly stressed column having bonded wire strain gages attached in such a way as to respond to the average strain on the column seemed a most promising solution to the problem of measuring loads of a million pounds or more. NBS instituted a project to develop load measuring devices of this type.

The program has now reached the point where eight devices have been completed and calibrated, four with a capacity of 1,000,000 pounds each and four with a capacity of 3,000,000 pounds each. Together the latter four offer a total capacity more than enough to calibrate the largest testing machine in existence.

Controlling Static Electricity With Electrostatic Neutralizers

ROBIN BEACH
Robin Beach Engineers Associated
Brooklyn, New York

The author is also an Associate with McCrossin & Company and an Adjunct Professor of Electrical Engineering at the Polytechnic Institute of Brooklyn.

First of two articles covering the use of electrostatic neutralizers for the control of static electricity in industrial process machines. Included is a basic discussion of the generation and control of static potential together with the operating principles of the commercially available types of electrostatic neutralizers.

Table I—Manufacturing and Processing Operations That Give Rise to High Static Electrification

1. Calendering of rubber plystock, plastic films and high quality paper.
2. Spreading or coating of rubber or plastic compounds onto textiles, paper or leather.
3. Sizing of textiles, paper or leather.
4. Backing of costly stock with textiles, compositions, rubber or plastics.
5. Drying in various forms by festoon, conveyor, or vertical dryers.
6. Multi-colored printing of newspaper, wallpaper, plastic sheeting and textiles.
7. Slitting and cutting of paper, textiles, coated products and plastic films.
8. Weaving, brushing, napping, rewinding, let-off and similar finishing operations in the textile industry.
9. Passing of paper, textiles, plastics, and rubber sheeting or films through systems of heating or cooling drums.
10. Let-offs from rolls of paper, textiles, plastic, and rubber sheeting or films.

ELECTROSTATIC NEUTRALIZERS are used to continuously discharge static electricity from dielectric stock that has become electrified by moving over contacting parts of process machines. Thus, their application is largely limited to certain phases of the paper, textile, rubber, and plastics industry, Table I, in which solid dielectric substances continuously move from let-off reels through a variety of intermediate processing operations to wind-up reels, folding, stacking, or equivalent terminal equipment.

For a particular application, the proper neutralizers are selected from the many types that are available and then located on the prototype unit of a line of processing machines. Thereafter, the type and location of a full complement of neutralizers can be specified for all similar units.

Uncontrolled static electricity can cause serious hazards to plants and operating personnel and to product quality and rates of production. Fires and explosions can result from the electrostatic ignition of flammable mixtures which arise from the use of industrial solvents and other flammable products. Personnel can be caught in the moving parts of machines by the involuntary muscular responses resulting from high voltage sparks and the accompanying electric shocks. Finally, high static potentials can affect the stock in such a manner that it cannot be processed correctly or rapidly. For example, synthetic yarn filaments will balloon or separate from one another from the repelling forces of static electricity. Under this condition, the yarn processing machine can only operate at about half capacity and the yarn strength is reduced because of poor overlay and entanglement of the filaments.

Most of these problems can be counteracted by the use of the proper type neutralizer located so that the residual static charge is reduced to a maximum level of a few

hundred volts. While the final location of a unit can be determined by the use of a simple instrument, selecting a neutralizer requires an understanding of the generation of static electricity and the operating principles and discharge characteristics of the various types of neutralizers.

Generation of Static Electricity

When two substances of any kind make contact, static electricity is generated at the contacting surfaces. Electrons accumulate on one surface, which assumes a negative polarity, while the surface of the other contacting substance acquires an equal charge of positive polarity.

When the two substances become separated, such as paper at the breakaway from processing rolls, most of the electrons remain on the substance to which they have migrated providing one or both contacting materials have such high electrical resistance that they are truly dielectric. Thus, the two materials acquire positive and negative charges; the static electricity accumulating equally on both.

If the processed material happens to be moist, its electrical resistance is reduced. Then at breakaway many of the electrons will return by conduction to the processing rolls, and the resulting electrification of the paper is low. However, with a dry material moving at high speeds, as in newspaper printing, practically all of the electrons which migrated from the rolls to the paper remain there because of the paper's high dielectric properties. Thus the electrification of the paper becomes excessive, exhibits a very high voltage, and is capable of causing undesirable sparks and mechanical problems of alignment.

Following the breakaway of the dielectric stock from the metal rolls, the electrical potential of the stock rises rapidly with respect to the zero potential that exists at the grounded metal processing or directional rolls. The potential of the accumulated static electricity with respect to ground attains values of thousands to hundreds of thousands of volts in many industrial operations. The potential of moving electrified stock from the breakaway from one roll to contact with the following roll is shown in Fig. 1. The dotted curve indicates the depressing effect on the voltage caused by the high capacitance of adjacent grounded metal parts.

Because of this high potential of the electrified stock with respect to ground, the accumulated electric charge is constantly seeking discharge to grounded structural members of the machine, and it is for this reason that sparks occur. These sparks range in length from a fraction of an inch to four feet and result in transient, repetitive and hazardous discharges from the electrified stock.

Reduction of Electrostatic Potential

All electrostatic neutralizers, regardless of their individual properties, provide a copious supply of positive and negative electric charges, called ions, within the intervening space between the neutralizers and the electrified stock. If the moving stock, such as newspaper web moving over steel rolls, is electrified to negative polarity, the positive ions will be attracted to the negative charges on the stock. Each positive ion combines with one negative charge, or electron, on the paper web, neutralizing it and reducing the electrification of the stock by one for each ionic combination.

If sufficient positive ions are present in the air near the paper web, all of the negative charges on the web become neutralized by their combination with the positive ions. Concurrently, the negative ions in the air gradually recombine with the positive ions or, in being repelled by the negative charges on the stock, they float away and are of no further concern. The same principle of discharge holds true for stock electrified to positive polarity, whereby negative ions in the air are attracted to and neutralize the charged stock. If insufficient ions are present in the air, only partial neutralization of the electrified stock can occur and a residual voltage, possibly of dangerous value, still remains.

Where flammable mixtures from industrial solvents are present, the electrification of stock should be reduced to a potential level of not more than 1,000 volts. In the absence of flammable mixtures, but for the safety of personnel, residual potentials should not exceed 10,000 volts. In some instances, electrification of only a few hundred volts can be troublesome, as in the jogging of paper in press work where even this low potential causes sheets of paper to stick together and slows down production.

Humidification of the stock or of the processing rooms has been used as a means of reducing stock potential by causing conductive discharge to ground. However, the processing operations are usually too rapid for the stock to absorb enough moisture to increase its conductivity sufficiently for bleeding off the electric charges. In addition, a high moisture content causes corrosion and accelerated deterioration of equipment in return for poor electrostatic control.

Machines whose parts make contact with and thus electrify moving stock should be grounded; however, this does not prevent the accumulation of static electricity on the stock. As the moving stock becomes electrified to one polarity, the machine parts accumulate an equal amount of opposite polarity. Thus, if the machine is not grounded, its potential will rise with respect to ground so that the operating personnel can receive shocks and recurrent sparks can occur between unbonded parts of the machine.

In the design of processing machinery, electrostatic potential control can be achieved by first specifying that all metallic machine parts be bonded and grounded and then selecting the proper neutralizer to reduce the charge on the moving dielectric stock.

Types of Neutralizers

Neutralizers are classified into two groups according to the manner in which they produce ionization of the air near the electrified stock. Pre-ionizing neutralizers are designated as Class 1 and induction neutralizers as Class 2. In addition, pre-ionizing neutralizers are subdivided into two general types: One applies a high potential to metallic ionizing needles arranged in linear distribution along the effective length of the neutralizer bar; the other employs a radioactive element along one side of the neutralizer bar. Fig 2 shows fourteen commercially available neutralizers of nine manufacturers.

High Voltage Pre-ionizing Neutralizers

In high voltage neutralizers, a central insulated conductor is connected to one terminal of the high voltage winding of a transformer, while the

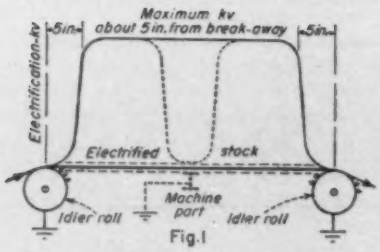
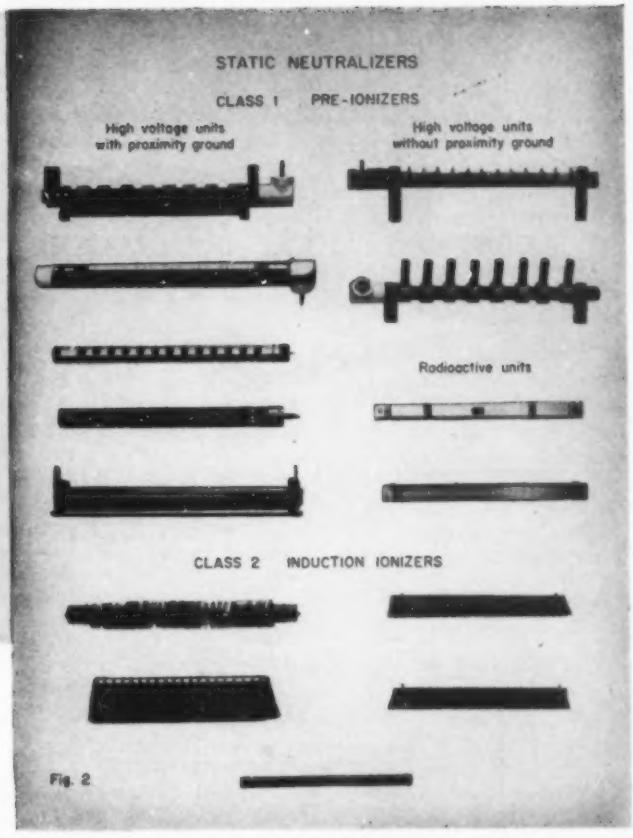


Fig. 1

Fig. 1—The rapid decrease of capacitor effect between the roll and moving charged stock causes an abrupt rise in voltage after break-away of the stock from an idler or processing roll. Dips in voltage (dotted curve) result from the localized high capacitance of grounded metal structures.

Fig. 2—Commercially available neutralizers of nine manufacturers, classified by the manner in which they operate to cause ionization.



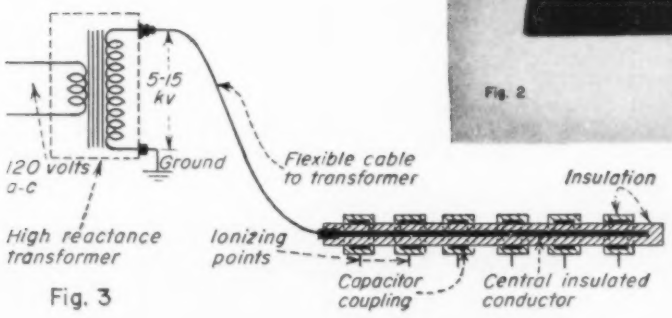


Fig. 3

Fig. 3—Schematic diagram of high voltage neutralizer. The insulated conductor is energized by cable from the high potential terminal of the transformer. Capacitor coupling of the individual ionizing points insures safety from electric shocks.

other terminal of the transformer is permanently connected to ground. The transformer high voltage ranges from about 5,000 to 15,000 volts depending on the neutralizer. Surrounding the insulated element are various types of split metal collars each with a projecting needle, Fig. 3. These collars form capacitor couplings with the central element so that a high voltage is applied to the metallic needles. The spacing of the needles along the neutralizer bar varies between ½ and 1½ inches.

This high voltage creates a high potential field force (potential gradient) at the needle tips, electrically overstressing the atoms of the gases composing the ambient atmosphere and forcing electrons out of these neutral atoms. The electrons that are freed from their atoms constitute negative ions in the air; and the residual atoms, each minus an electron, constitute the positive ions. Thus the air between the neutralizer and the electrified stock becomes charged with a supply of positive and negative ions.

Several high voltage neutralizers use proximity ground rods or grounded metal housings located within a fraction of an inch of the ionizing points, Fig. 4. With this type, 5,000 volts is sufficient to cause copious ionization of the air. If no grounded rod is located close to the needle points, as an integral part of the neutralizer, then the highest practicable applied voltage of about 15,000 volts is necessary to create a reasonable amount of ionization.

The degree of air ionization is higher for the high voltage neutralizers with proximity grounds than for those without proximity grounds in the approximate ratio of 25 to 1. However, neutralizers without grounds can sometimes be mounted in such a manner that structural parts of the machine can serve as adjacent ground rods. This increases the low ionizing effectiveness of these neutralizers.

Radioactive Pre-ionizing Neutralizers

These neutralizers currently use radium, polonium or a combination of both as the ionizing element. In the radium unit, the radium activator is contained in thin gold and aluminum envelopes about ¼ in. wide. These are mounted in a recessed trough which extends the effective length of the neutralizer. The essential component of radium which ionizes the air

Fig. 4—High voltage neutralizer with two proximity ground rods near the ionizing points. Special high reactance transformer limits output current safely below the lethal level.

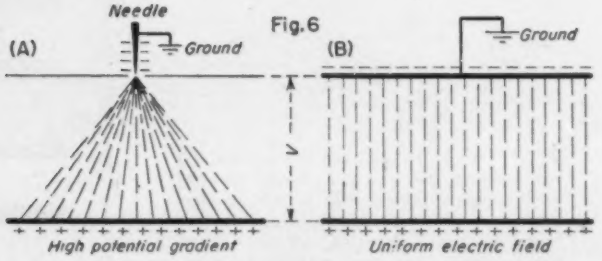


Fig. 5—Cross-section of radium type neutralizer. Alpha radiation in the form of double positive charges is emitted by the radioactive material. Although units operate most efficiently when located close to the electrified stock, they will work satisfactorily at distances up to three inches.

Fig. 6—Convergence of electric field to needle point, such as used in induction neutralizer, (A) gives much greater ionizing potential than would the uniform electric field between parallel condenser plates (B) for an equal voltage, V, across both devices.

Fig. 7—Tufted type induction neutralizer. The tufts of fine wire bristles spaced along a treated wooden bar increase the amount of ionization over that obtainable with single needle points. This unit will lower the threshold of ionization to a level of a few hundred volts.

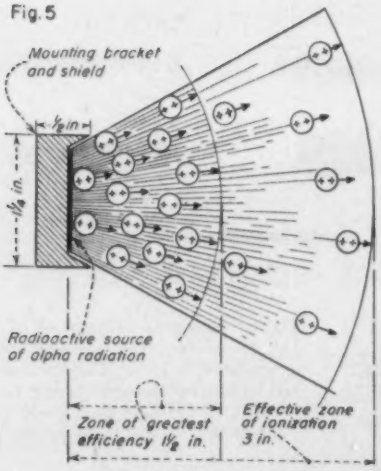
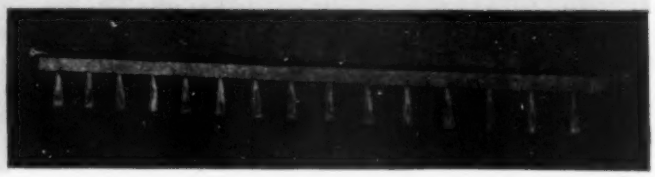


Fig. 5
Mounting bracket and shield
1/8 in.
1 1/8 in.
Radioactive source of alpha radiation
Zone of greatest efficiency 1 1/2 in.
Effective zone of ionization 3 in.



is the alpha emission. This radiation consists of minute particles emitted by the nuclei of radium atoms, each alpha particle bearing two unit charges of positive electricity, Fig. 5. Although the zone of greatest efficiency is within 1½ in. of the neutralizer, these particles can effectively ionize air atoms by bombardment and collision for a distance of about 3 inches. Beyond this distance, their energy level becomes too low for further ionization.

Although the ratio of the ionizing current of these radium bars as compared to high voltage neutralizers with proximity grounds ranges down to about 1 to 100, they have certain advantages with regard to space factors and safety from fire and explosion hazards which sometimes result in their use for critical applications.

Since emitted alpha particles consist of doubly charged positive ions, their intial speed and ionizing energy is reduced by the strongly repelling influence of charged stock when it is highly electrified to positive polarity. This behavior imposes an additional restriction on the already limited service of the radium neutralizer.

In addition to the desired alpha emission, radium also emits beta and gamma radiations which possess undesirable erythermal and hard X-ray effects. These are deleterious to human tissue, and this type of neutralizer should be installed in strict compliance with the recommendations of the manufacturer and must conform to the regulations imposed by the offices of public health.

Although the half-life period of radium is 1,690 years, the life span of the radium neutralizer depends on the cleanliness of the environment in which it operates. The exposed surface of the radium activator is sensitive to collections of air-borne dust and vapors so that after a few years of operation, the face of the activator strip becomes so impregnated with alpha absorbing contamination that further cleaning with solvents fails to restore its ionizing potency. Hence, reconditioning or replacement of the deteriorated neutralizers eventually becomes necessary.

Polonium neutralizers, unlike radium units, utilize an element that emits only alpha radiation. As currently manufactured, the polonium bars give about five times the discharge current obtained from conventional radium bars. The half-life period of polonium is only 144 days in contrast to the 1,690 years for radium. By overloading the amount of polonium used in these neutralizer bars, a short industrial life approximating two years is attained. Ionization by polonium bars is also adversely affected by highly electrified stock of positive polarity.

The polonium neutralizer also presents a health problem which arises from the toxity of polonium dispersion. This occurs through ingestion of the polonium powder which accumulates on the surface of the neutralizer. To minimize this potential health hazard, the polonium element is electroplated with a thin layer of gold. However, this and other precautions have not completely satisfied public officials who still critically inspect all installations of this type neutralizer.

Induction Neutralizers

Induction neutralizers require no external power source and operate on the principle of electrostatic induction. If a grounded needle is located an inch or so from electrified stock of positive polarity, then the ground-seeking electric field from an extensive area of the stock will converge onto the nearby point of the needle which acquires a strong negative polarity by inductive attraction. Electrification by induction always causes a potential of opposite polarity to that of the inducing electrification.

Because of the convergence of the distorted electric field from the stock to the grounded needle point, a condition of high electrical intensity exists at the point, Fig. 6(A). This is in contrast to the low intensity uniform field that would exist for the same difference of potential if the needle point is replaced by a large flat sheet of grounded metal located parallel to the stock, Fig. 6(B). A voltage, V, of 500 volts or less can give a high potential ionizing gradient of several thousand volts per centimeter near the point of the needle by virtue of the increased intensity of the convergent electric field.

If interconnected grounded needles are spaced an inch or two apart along a wooden bar across the full width of the stock, and the needle points located about an inch from the stock, then ionization of the air will occur between the points and the electrified stock. In this manner the voltage of the stock to ground can be reduced to a threshold of ionization of only a few hundred volts.

In one type of commercially available induction neutralizer, Fig. 7, (not shown in Fig. 2) small tufts of grounded hard-drawn brass bristles are mounted along a treated wooden bar. The bristles are more practical than needles and give double the ionization. This is an effective, inexpensive, safe, and durable electrostatic neutralizer and will give satisfactory service in a large number of applications.

Other types of induction neutralizers have wire bristles packed solidly and continuously along the length of some form of metal backing frame. These require a relatively high threshold potential at the stock before they start ionizing, and their ionizing potential is low because any one bristle is completely shielded from high electric field gradients by the proximity effects of large numbers of neighboring bristles. In general, this type of neutralizer does not reduce the voltage of the stock to values as low as are required for safe and satisfactory service.

Editor's Note: Part II of this article will be published in the November issue of *Product Engineering*. It will cover the discharge characteristics of the various types of neutralizers, safety considerations and the preferred method for locating neutralizers.

Table II—Manufacturers and Types of Electrostatic Neutralizers

Manufacturer and Address	General Type of Product
HIGH-VOLTAGE NEUTRALIZERS	
Chapman Electric Neutralizer Co. P. O. Box 268 Portland 6, Me.	Neutralizers of the 5,000-volt class with proximity grounds and also neutralizers of the 15,000-volt class without proximity grounds.
The Simco Company 920 W. Master Street Philadelphia 22, Pa.	Neutralizers of the 5,000-volt class with proximity grounds.
Herbert Products Inc. 74-32 Jamaica Avenue Woodhaven 21, N. Y.	Neutralizers of the 15,000-volt class without proximity grounds.
The TAKK Corporation Newark, Ohio	Neutralizers of the 5,000-volt class with proximity ground rods.
RADIO-ACTIVE NEUTRALIZERS	
United States Radium Corporation 535 Pearl Street New York 7, N. Y.	Radium *Ionotron* neutralizer bars.
Canadian Radium & Uranium Corp. 630 Fifth Avenue New York 20, N. Y.	Polonium *Alphatron* neutralizer bars.
INDUCTION NEUTRALIZERS	
Western Brush Co, Inc. 215 South Western Avenue Chicago 12, Ill.	Induction neutralizer with radial wire bristles in continuous circular array secured by substantial central supporting and binding wires.
Herman H. Sticht Co, Inc. 27 Park Place New York 7, N. Y.	Induction neutralizer *The Magic Wand* with spaced tufts of wire bristles supported along a specially-treated wood bar.
The Fuller Brush Company Hartford 2, Conn.	Induction neutralizers with wire bristles or mixtures of wire and hair bristles packed densely along the length of metal backing frames.
The Osborn Manufacturing Co. 5401 Hamilton Avenue Cleveland 14, Ohio	Induction neutralizer with wire bristles packed densely along the length of a metal backing frame.

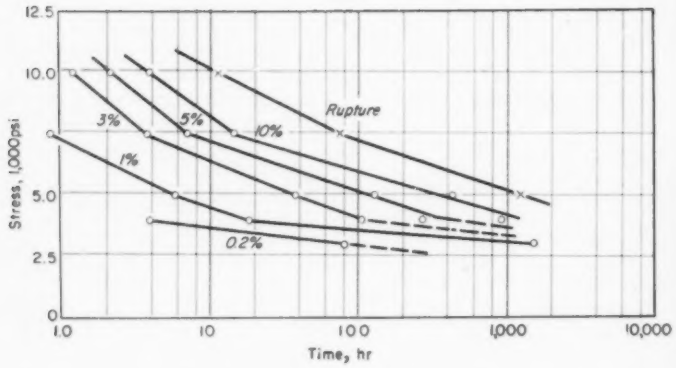
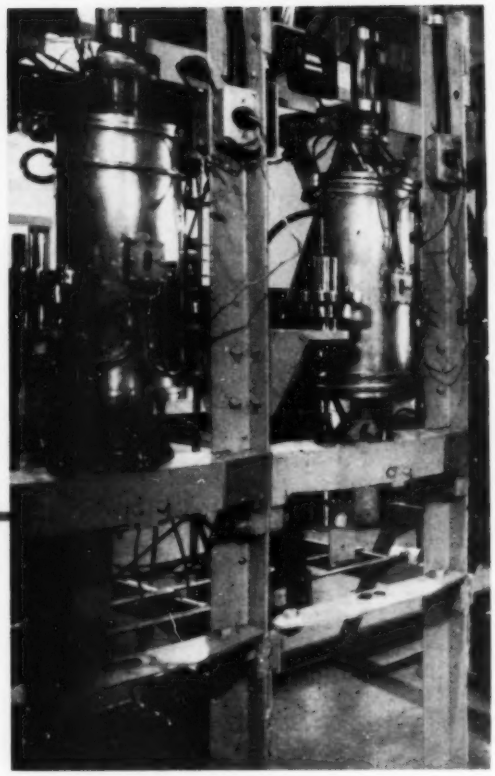


Fig. 1—Design curves for titanium RC-70 sheet at 1,000 F, in which stress-rupture time and stress-deformation time are both presented. The top curve is the usual stress-rupture time curve. Breaks in the rupture curve indicate changes in internal structure and usually signify reduced strength. The lower curves for amounts of total deformation include plastic deformation.



High Temperature Test And Their Importance

HOWARD C. CROSS
Metallurgist, Battelle Memorial Institute

DATA FOR HIGH TEMPERATURE DESIGN are developed mainly from rupture tests and creep tests. In both tests, materials are tested at a constant temperature under a constant load.

After rupture test data are obtained, if the stress is plotted against the time for rupture on a logarithmic scale, an approximately straight line is obtained. The slope of this line depends on the test temperature and the material. Usually the slope becomes greater as the temperature is increased. If the surface or structure of a material is not stable, one or more changes in slope may occur.

These log-log plots are quite useful for interpolation and for reasonable extrapolation if other characteristics of the material are fully known. For example, if a designer extrapolated rupture data for low carbon steel, he might conclude that the steel possessed usable strengths over appreciable time periods at 1,200 F. Oxidation is severe at this temperature, however, and the expected service life may not be realized because of loss of section with correspondingly increased stress. More information than load-carrying ability is needed to make a wise choice.

Failure usually does not occur in a creep test. In this test, a specimen is heated to the desired test temperature and the desired load is applied. As with rupture data, a log-log plot of stress against creep rate usually gives a straight line. At low stresses and creep rates, as indicated by McVetty, the data sometimes follow a hyperbolic sine law rather than an exponential law with the curve increasing in slope at the lower rates. In creep testing, a complete time-deformation curve is ob-

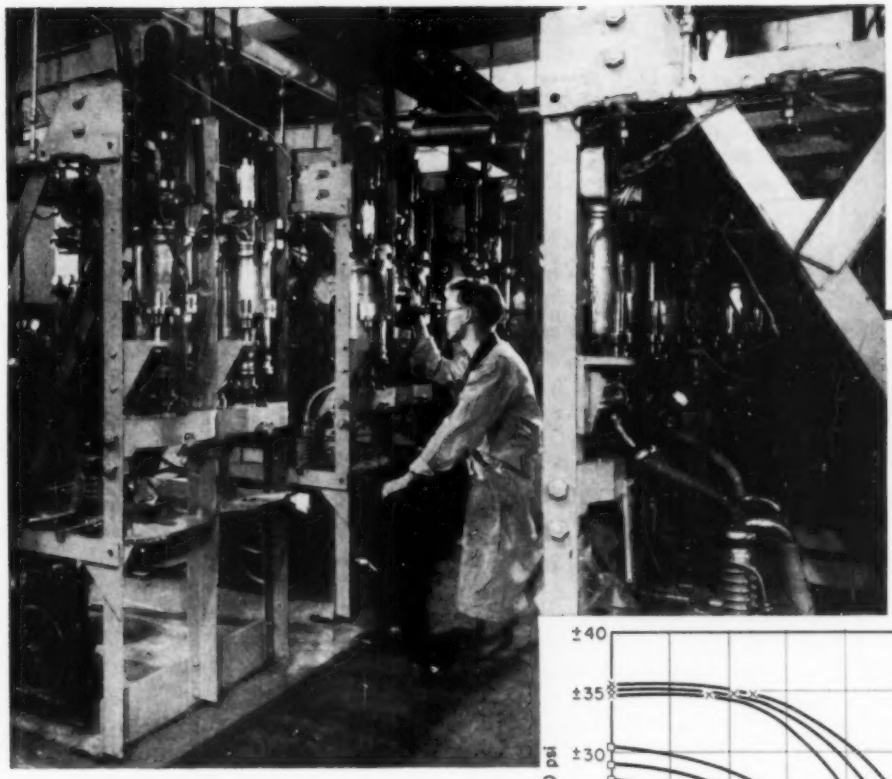
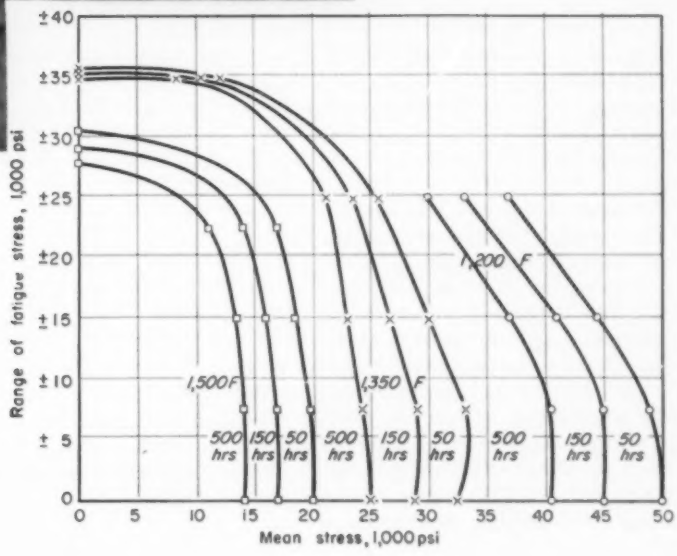


Fig. 2—Vacuum creep laboratory at Battelle Memorial Institute for research study of the properties and the behavior of materials at high temperatures.

Fig. 3—Mean stress that can be sustained by N-155 alloy with increasing dynamic stress superimposed for different rupture times and temperatures.



Data in Design

tained. From this curve, rates of deformation and data can be plotted for design curves.

In the plot of a typical creep curve, the first stage is one of decreasing creep rate immediately following application of the load. The second stage is one of approximately constant creep rate. The transition point denotes the time at which the creep rate begins to increase. The third stage is one of rapidly increasing creep rate immediately preceding rupture. These stages are sometimes poorly defined and may cover extended periods, depending on the material and temperature.

Many design engineers request that the results of both rupture and creep tests be combined to construct so-called design curves. These curves show the relation between stress and time for rupture, transition point, and the various amounts of total deformation at a fixed temperature.

Such a design curve is shown in Fig. 1 for commercially pure titanium RC-70 at 1,000 F. The top curve is the usual stress-rupture time curve. Below this curve, the transition point is sometimes indicated with a broken line. This point serves as a danger signal; any application that falls above the point would be in a condition of rapidly increasing deformation rate leading to early failure. Breaks in the rupture curve indicate changes in internal structure and usually signify reduced strength.

The lower lines of Fig. 1 are for amounts of total deformation. Note that since these data are scaled from the time-deformation curves of both the rupture and creep tests, the values for total deformation include the elastic deformation resulting from application of the load as well as the subsequent plastic deformation.

For an example of the value of such

design curves, assume that a designer is considering RC-70 sheet for 500 hours of service at 1,000 F, and in this time the deformation is not to exceed a total of 1 percent. A reference to Fig. 1 will indicate that a maximum stress of 3,300 psi can be sustained under the conditions cited.

Such design curves possess some inherent disadvantage. At the longer times, the curves for total deformation bunch together so that accurate extrapolation to long times may be difficult for the designer to calculate.

Effect of Variables on Design

Through long experience, steel and alloy producers have developed effective techniques for controlling the composition of heat-resisting materials. For the superalloys developed for gas-turbine service, composition is likely to be a minor variable.

Data obtained on a particular heat of material, should not be assumed to be representative of that for all heats of the same composition. The conditions under which alloys are cast, forged, rolled, or heat-treated sometimes affect properties more significantly than does composition. The variation in properties that results from different material processing treatments must be considered in design.

Assume, for example, that an engineer is designing a precision-cast turbine bucket for a jet engine. The rupture properties of a cast cobalt-base alloy vary depending on the casting temperature and the mold temperature. These variables affect both the internal structure and the grain size. If a large number of heats are tested at a single temperature and load, a range of rupture times is obtained. What value should the engineer use in design: the average, maximum, or minimum?

In a jet engine, the engineer does not want any blade to fail, ever. To keep the percentage of anticipated failures to a low figure, he is forced to use a value close to the minimum.

The data that show the spread in properties, however, spur the castings manufacturer to greater efforts in understanding and controlling his process so that he may reduce the spread in properties from heat to heat and casting to casting.

When a material serves in a high-temperature installation there are usually periods in which the service temperature exceeds the design temperature. Aside from the accelerated creep rate that occurs, there is always the problem of the effect of such over-temperature exposure on the internal structure of the alloy.

Some of the ferritic materials, such as the Cr-Mo and Cr-Mo-V bolting steels, are, during their heat-treatment, tempered at temperatures considerably in excess of their operating temperature. In this instance, temporary service at slightly increased temperature produces little or no structural change.

In some of the superalloys, the effect of overheating can be serious. If an alloy is of a type that is given a solution and aging treatment, but that overages upon overheating, and the aging process is not reversible, decreased strength results. Some alloys, however, lose some strength upon overheating but quickly regain their former strength upon continued service at the design temperature. In using these types of materials, the designer needs to know the effect of overheating on properties as well as the strength resulting from the optimum heat-treatment.

Stress-rupture tests are sometimes used as acceptance tests to determine whether individual heats possess the desired level of high-temperature strength. Such short-time rupture tests, usually of 25 to 50 hours duration, are only usable when a considerable amount of testing has been done on the particular alloy and the designer is fairly certain of the relation between rupture data from relatively short-duration tests and long duration tests.

It makes a difference whether strength determinations are made on small heats or large heats, on bar stock or on specimens cut from fabricated and finished parts. In some alloys, fabrication procedures have been so carefully studied and controlled that specimens taken from finished parts have a stress-rupture life equal to that of specimens taken from bar stock. In others, rupture properties are the same but the service life falls short of expectations. This discrepancy means that all operating variables are either not understood by the designer or not under control by the fabricator.

Significantly lower strengths are shown by material subjected to high-temperature testing in the cold-worked condition when compared with the strength of properly solution-treated and aged material. A designer, consequently, may properly utilize the strength of an alloy in a suitable design but have a premature and costly failure as a result of an improper finishing operation. An improper final finishing operation on a turbine blade may leave a cold-worked surface less than 0.001 in. deep that results in a significant reduction in blade life.

Deformation and Cyclic Loading

In the field of cyclic loading, the rate of deformation under cyclic stress conditions depends on a combination of variables of which temperature, frequency of cyclic stress, and amplitude of cyclic stress are especially important.

From the results of experiments, at Cornell Aeronautical Laboratory, on low carbon N-155 tested at 115 cycles per minute, with stress amplitude of 25 percent of the mean stress at temperatures of 1,350 and 1,500 F, it appears creep rate, creep deformations, and fracture times characteristics of static mean stress are not affected.

The effect of superimposed dynamic stressing on rupture life of low carbon N-155 has been studied still further at Battelle. The results obtained are shown in Fig. 3. This plot shows fatigue-stress versus mean-stress curves of the N-155 alloy for rupture times of 50, 150, and 500 hours at 1,200, 1,350, and 1,500 F. The horizontal scale shows the mean or static stress for rupture for the times and temperatures indicated. Curves show mean stress that can be withstood with increasing dynamic stress superimposed.

Note that, as reported by Cornell, at 1,350 and 1,500 F, dynamic superimposed loads of ± 25 percent do not

affect the rupture life. At higher levels of dynamic stressing, the mean stress for constant life decreases until finally, for zero mean stress, the completely reversed loading fatigue stress is shown. The data in Fig. 3 indicate that the effect of superimposed dynamic loading is more marked at the lower test temperature of 1,200 F than at 1,350 and 1,500 F.

Cyclic temperatures are also experienced in some high-temperature applications. Since deformation rate changes so rapidly with temperature, it is difficult to predict by mathematical analysis just what will happen. Rapid changes in temperature, with the loads removed during the change, produce much less effect, and deformations are predictable by computation. Slow temperature cycling, above and below mean temperature, results in a rupture life less than that for steady exposure at mean temperature.

Extreme temperature cycling at a rapid rate can produce effects as a result of thermal shock. Materials differ in their resistance to thermal shock. A design based on strength characteristics alone, without consideration of the sensitivity of a material to a rapidly changing environment, can be risky. Some engine manufacturers evaluate potential blade alloys by alternate rapid heating and cooling of blade airfoil sections.

Sheet material for the skin of a ballistic missile, or of a ramjet rocket motor, is among the high-temperature applications that require special testing techniques.

In tests to obtain design data on a variety of sheet materials, test specimens have been loaded cold, heated rapidly (200 to 400 deg F per sec) to the desired testing temperature and then maintained at a constant temperature for a desired period, usually up to about 5 hours. In these tests, deformation characteristics are measured from the initial load-on cold condition. Total deformation, therefore, includes the elastic extension cold, the thermal expansion, the deformation resulting from the change in elastic modulus, and the deformation resulting from the applied stress both during heating and at constant maximum temperature. Stress-total deformation data obtained from specimens under load for one minute, at three temperatures, are given in Fig. 4 for several commercially available sheet materials.

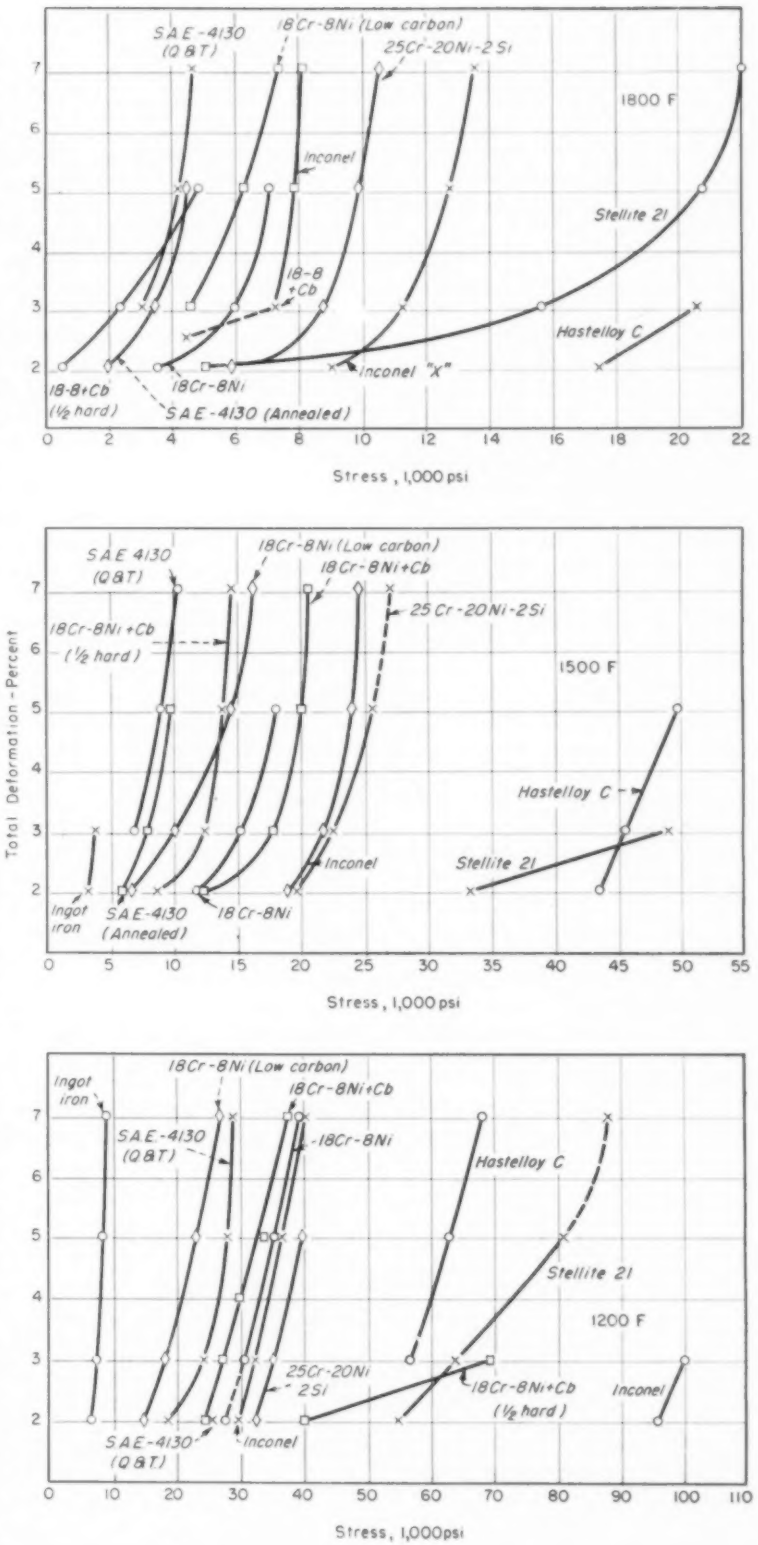


Fig. 4—Stress-total deformation curves for several heat-resisting alloy sheet materials under load for one minute. The total deformation includes the elastic extension cold, the thermal expansion, and the change in the elastic modulus.

Properties of Molybdenum and Molybdenum-Base Alloys

The production of molybdenum by powder-metallurgy techniques and the development of a successful arc-melting and casting process has increased interest in molybdenum and its alloys. The data to be reported here were obtained in research on "A Metallurgical Study of Molybdenum" for the Office of Naval Research and in research for the Wright Air Development Center.

To determine high-temperature properties, pure molybdenum samples were obtained from various producers. Some samples were tested in the as-received (hot-worked) condition, and some in either the stress-relieved or the recrystallized condition. The details of the fabrication procedures are not available for many of the samples.

Stress-rupture tests were made at 1,600, 1,800, and 2,000 F. Because of the poor oxidation resistance of molybdenum, all tests were made in a vacuum. In Fig. 5 are shown the ranges of properties obtained at the three temperatures.

Molybdenum, as do the so-called superalloys, shows a considerable variation in properties, depending on how it is fabricated and the condition in which it is tested. In these tests, the lowest rupture strengths are shown by metal recrystallized before testing; and the highest, by molybdenum in the as-rolled or swaged conditions.

Examination of the microstructures of the molybdenum specimens after stress-rupture testing indicated varying degrees of recrystallization, depending on the material, the temperature and duration of the test. In some tests at 1,600 F, the hot-worked fibered structure showed a creep-rupture strength about 10,000 psi greater than the recrystallized equiaxed structure. At 1,800 F, this superiority is practically lost in long-duration tests. Ductility as indicated by elongation at rupture was good. Only in extended tests at 2,000 F were elongations of less than five percent obtained.

Under a contract with the Wright Air Development Center, work is in progress on the effects of fabrication variables on the recrystallization of unalloyed molybdenum produced by the powder-metallurgy process. This work has been in progress only a short time, therefore, results are incomplete.

Rupture tests, however, indicate that better high-temperature characteristics could be obtained if recrystallization could be retarded or controlled by processing. Vacuum sintered molybdenum and hydrogen sintered molybdenum act differently. In vacuum sintering, a higher temperature is required to produce recrystallization. Vacuum sintering sometimes promotes unusual grain growth in the form of large elongated grains.

Test results show that there is no significant difference in the extent of recrystallization between 10 and 20 percent reduction by rolling per pass at 2,280 F, that the combination of a 24-hour mid-point anneal and 60 percent reduction produced essentially no recrystallization even after a stress-relieving treatment of ½ hour at 2,010 F, and that, with no mid-point anneal and 90 percent reduction, both the vacuum sintered and the hydrogen sintered materials recrystallized to some degree.

The use of 60 percent reduction rather than greater amounts following the mid-point anneal appears to be desirable, and the use of lower reductions, about 30 percent, appears to be even better.

Other tests to determine suitable stress relieving treatments have been conducted with five arc-cast molybdenum-base alloys obtained from the Climax Molybdenum Company. One alloy contained 2.4 Ti; another 0.32 Cb; another, 0.67 V; another, 0.85 V; and another, 0.04 Co. All five materials were heat-treated for one hour at 1,800 F, following which the temperature was increased in 200 deg F increments until the materials showed complete recrystallization.

The 2.4 Ti alloy did not recrystallize completely until treated at 3,200 F. The other four alloys recrystallized between 2,000 and 2,400 F.

Stress rupture tests were then made at 1,600, 1,800, and 2,000 F on these alloys in both the stress-relieved and the recrystallized conditions. Results of these tests are shown in Figs. 6(A), (B) and (C). For purposes of comparison, the range of properties obtained for unalloyed arc-cast and powder-metallurgy pure molybdenum is included.

At 1,600 F, Fig. 6(A), the strengths for four of the recrystallized alloys containing Co, Cb, and V fell in the upper part of the range for the pure molybdenum, indicating a strengthening effect from the alloy addition. The strengths for the stress-relieved alloys were 20,000 to 25,000 psi greater and the superiority was maintained even at the longest testing periods.

At 1,800 F, Fig. 6(B), the same relationships were observed. Note that the 0.85 V alloy showed the greatest strengths, although the difference was small. The stress-rupture-time curves for the 0.04 Co and 0.67 V alloys show a change in slope at testing times slightly in excess of 100 hours, probably as a result of recrystallization during the testing.

At 2,000 F, Fig. 6(C), the strengths

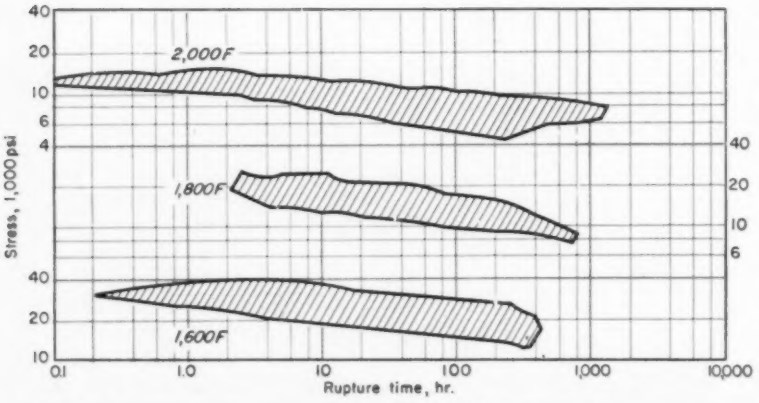


Fig. 5—Stress-rupture test results on pure molybdenum samples. Because of poor oxidation resistance of the metal, all tests were made in a vacuum.

of the stress-relieved and the recrystallized alloys are quite similar, probably because of this test temperature, recrystallization occurs rapidly under stress. Note that at 2,000 F the molybdenum-base alloys consistently show greater strengths than does pure molybdenum.

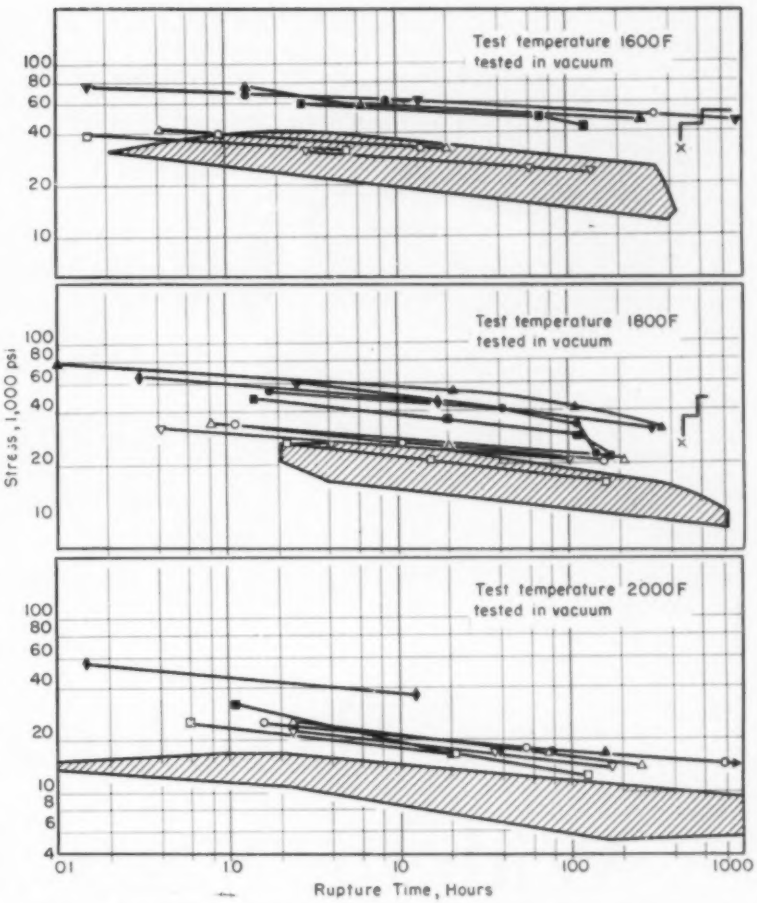
The alloy reported to contain 2.4 Ti showed some promising results in tests at 1,600 and 1,800 F. After testing in excess of 400 hours, the stress was increased several times for periods of 100 hours, still without failure. Additional tests on this heat could not be run because of faulty material.

A replacement alloy, reported to contain 2.46 Ti, was found on analysis to be probably lower in titanium content than the previously tested alloy. At 1800 F, the replacement alloy in the stress-relieved condition is not as strong as the 0.85 V alloy; but at 2,000 F, the replacement alloy shows considerably higher strength than the other alloys.

A comparison of 1,000-hour rupture strengths for molybdenum alloys, stainless steel, some superalloys, and ceramels is shown in Fig. 7. The bottom boundary of the area for molybdenum alloys shows the best values obtained for pure molybdenum in the stress-relieved condition and the top boundary of the area shows the properties for the best molybdenum-base alloy tested to date.

Note that as compared with the superalloys, a significant improvement in strength has been made, with considerably higher strengths at comparable temperatures such as 1,600 and 1,800 F, and comparable strengths at increased temperature levels. The strength level for a strong ceramel is also indicated. It should be pointed out that none of the values shown in Fig. 7 has been corrected to take into account the densities of the various materials.

The high-temperature properties cited for molybdenum and molybdenum-base alloys are encouraging. As more is learned about alloying and fabrication, it is possible that still higher strengths may be obtainable. It is hoped that there will soon be available some consistent means of protecting these molybdenum-base materials from oxidation so that their promising long-time strength properties can be utilized.



Alloy	Recrystallized condition	Stress-relieved condition	Alloy	Recrystallized condition	Stress-relieved condition
2.46 Ti	◊	♦	0.04 Co	○	●
0.32 Cb	▽	▼	0.67 V	□	■
0.85 V	△	▲	2.4 Ti	×	

Fig. 6—Stress-rupture tests on arc-cast molybdenum-base alloys. Shaded areas show properties of unalloyed arc-cast and powder-metallurgy pure molybdenum.

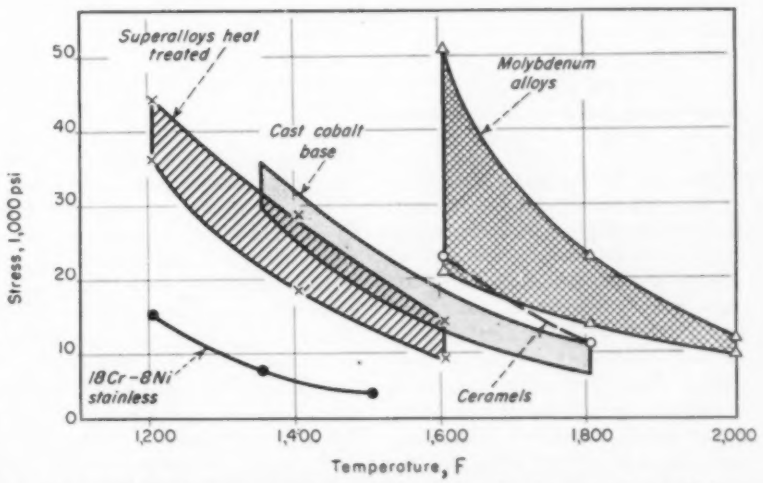
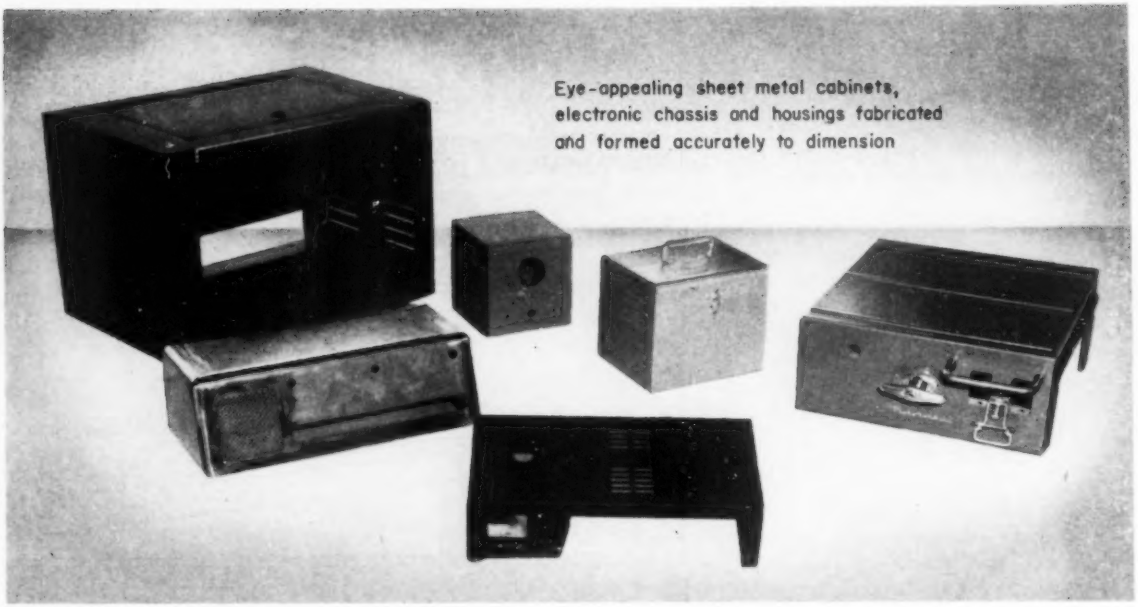


Fig. 7—Comparison of 1000-hour rupture strengths for several materials.



Eye-appealing sheet metal cabinets, electronic chassis and housings fabricated and formed accurately to dimension

Sheet Metal Design With the $ Sign in Mind

Small design details that cost the customer money and how to avoid them. Cost penalties for overlooking minor considerations in the design of sheet metal parts and assemblies. Economies that result from designing to avoid grinding and sanding operations. Advantages of light gage construction.

HERB C. GOLZ
Design Engineer, Elgin Metalformers Corporation

MANUFACTURERS without sheet metal design, engineering, and fabrication facilities are dependent upon outside suppliers to fill their sheet metal requirements. These manufacturers buy sheet metal fabrications and components that satisfy the specifications of their engineering and sales departments. These parts must fit properly in assembly operations; they must have correct styling for utmost sales value; and they must be priced so that the end product is competitive.

A mutual problem, therefore, exists between the user and the supplier—how to achieve correct sheet metal fabrications that are designed with an eye on the dollar sign.

The manufacturer who must buy sheet metal housings, enclosures, chassis, cabinets, or other components can make a definite contribution toward better sheet metal design at lower costs. When the project is large, he should insist upon periodic visitations between his plant and that of his suppliers by the production, engineering and design personnel involved. The better each group understands the aims, requirements and problems of the other, the better will be the end product.

Like the design of the end product itself, be it a toaster, a television set or a mammoth electric power control board, the sheet metal components should be designed and purchased at the earliest practicable time.

Cost is not always controlled by big items; small items, or combinations of small items, have a direct bearing on the final cost. Overall cost usually can be scaled down by paying strict attention to basic design elements.

One element of basic design upon which many engineering departments place great emphasis, but take little cognizance of the costs involved,

centers upon blanket tolerances for hole sizes, hole center distances and overall dimensions; especially where the sheet metal part has formed flanges or sides.

Tolerances, of course, should never be relaxed simply to fit the facilities of a particular supplier. Tolerances should be established with a realistic attitude that results in no loss of function but a marked decrease in cost. The sheet metal supplier appreciates knowing what tolerances he must adhere to and what tolerances allow him some leeway. With such information, he can quote prices that include a profit and, at the same time, give his customer a sheet metal fabrication of superior quality at low cost.

On production runs, it is difficult to maintain dimensions between two bends in 16 gage cold rolled sheet steel to better than plus or minus $\frac{1}{32}$ in., therefore, it is ridiculous to specify a tolerance of plus or minus $\frac{1}{64}$ in. If such close tolerance must be held on a formed part, it should so be specified; but with full knowledge that such specification may require the fabricator to use tooling that will add dollars to the cost. With a reasonable tolerance, no tooling charge would be added to the cost for the use of standard press brake dies.

Tolerances of assembly location are sometimes set up that cost many dollars to fulfill. The location of part mounting holes too close to a formed edge is one certain way to increase piece part price. Mounting holes punched too close to a formed edge distort in the forming operation and result in a poor appearance that may be cause for rejection of the piece. To avoid distortion, holes so located must be punched after forming. This sequence of operations necessitates costlier tooling, slows production, increases handling, and results in a higher piece part cost. With proper tolerance allowed in the basic design, such hole locations can be punched in the flat blank and a direct cost savings effected.

All tolerances should be reasonable, exact where they must be, but not a blanket assumption as is the practice in the majority of sheet metal drawings. Because it is almost asinine to allow a plus or minus $\frac{1}{32}$ in. regardless of whether the dimension involved is $\frac{1}{4}$ in. or 9 in., some engineering departments use a sliding tolerance scale in which plus or minus $\frac{1}{64}$ in. is allowed on dimensions up to 6 in., with as much as plus or minus $\frac{1}{16}$ in. on dimensions above 24 in. This reasonable and realistic approach saves tools and time.

Flanges and Notches

Wherever sheet metal parts such as doors, pans, covers, and channels are flanged, it is good practice to standardize on the size of the flange, be it $\frac{1}{2}$, $\frac{5}{8}$, or 1 in. The more one size flange is used throughout the fabrication, the fewer will be the set-ups in press brake operations, with a corresponding saving of time. Many engineers, of course, are thoroughly familiar with sheet metal fabrication practices and can competently establish the size of a flange. It may be better cost-wise, however, to let the supplier follow his standard practice on flanges in the fabrication of common shapes.

Many times a certain shape factor is specified for a corner notch where a part is to be formed on two, three, or four sides. This practice, however, should be avoided unless it is necessary for function or appearance. Most sheet metal fabricators follow standard notching procedures; these include standard notches for sheet metal boxes and pans, and relief notches for aluminum products. If special notches are required, then a higher cost of purchased part must be accepted; otherwise, specify standard notches wherever acceptable and save money.

A standard box notch, employed by practically every sheet metal fabricator where design calls for the spotwelding of corners as in covers, chassis and boxes, is shown in Fig 1(A). This type of notch is produced by one stroke of the press per corner.

Although sometimes specified by engineers, the notches shown in Fig. 1(B) and (C) should be avoided. Without special tooling, at least two press strokes per corner are required to produce these notches.

Hole Sizes and Internal Threads

When sheet metal parts or assemblies are fastened onto or into an end product, hole sizes must be specified for the screws, bolts or rivets used in assembly operations. Here, designers and engineers usually go astray by specifying hole clearances that are correct for machine shop products but not for mass produced sheet metal fabrications.

In bases, plates and components that are mounted at specific locations, of course, holes a few thousandths of an inch larger than the screws that

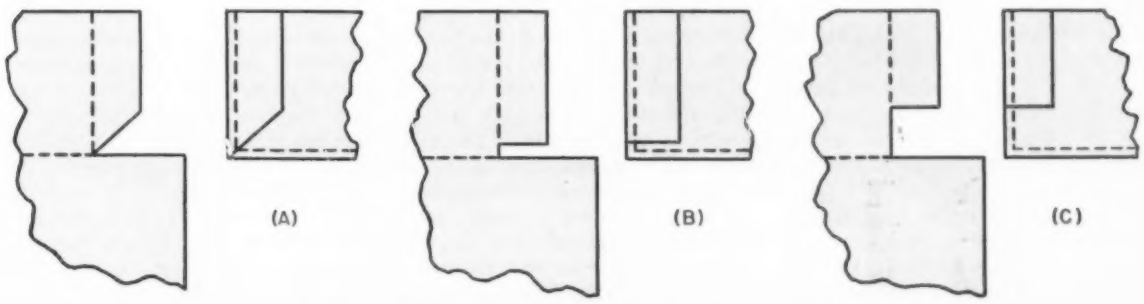


Fig. 1—Notches for spotwelded box tabs: (A) Standard; produced in one press stroke. (B) and (C) Non-standard; without special tooling, at last two press strokes are required to produce.

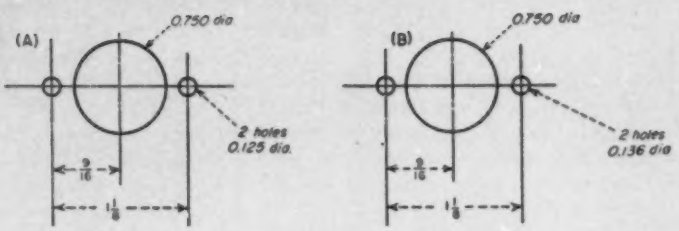


Fig. 2—Lack of standardization; both hole clusters are intended to receive the same type of tube socket but drawings call for different clearances.

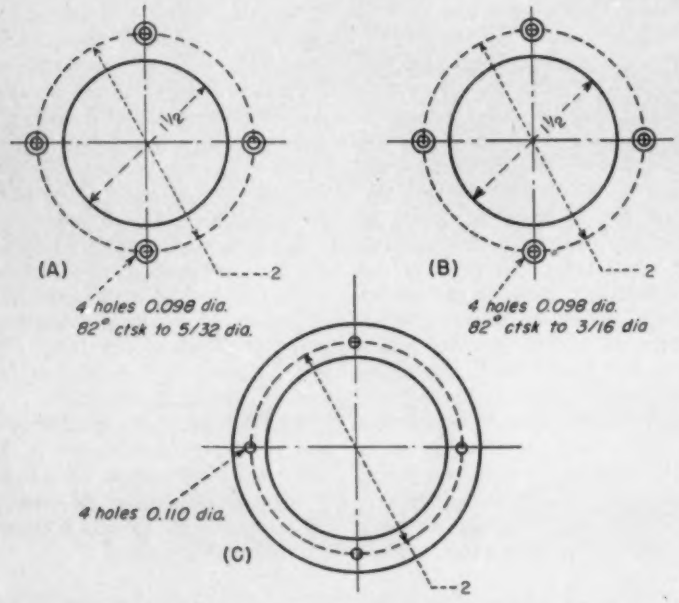


Fig. 3—Standardization would have avoided calling for two diameters of countersink and two diameters of punched holes. Each uses same size screw.

enter them are usually called for. Where close clearance is not of importance, $\frac{1}{4}$ in. holes are not too large if the assembly calls for 10-32 screws. Ample clearance promotes faster location and assembly and saves time.

Holes should have standard or common dimensions. For example, do not specify a 0.154 hole when 0.157 dia will do as well. Most sheet metal suppliers have $\frac{5}{32}$ (0.157 dia) punches and dies but will be obliged to add to the tooling cost if the 0.154 hole is insisted upon.

When specifying hole sizes, keep in mind that the fewer the number of punch and die sizes required, the less will be the press time. First decide on the number of holes that will be required in the different sizes deemed necessary, then reduce the number of sizes by selecting holes that will fill as many requirements as practicable.

Select hole sizes and locations to take advantage of the savings offered by the multiple hole punching systems now available. These systems enable a fabricator to punch a hundred or more holes per press stroke in 16 gage cold rolled steel with hole diameters ranging from 0.078 to $\frac{3}{8}$ in., and on centers as close as $\frac{1}{2}$ in. The purchaser of sheet metal fabrications that contain a large number of holes, such as chassis or mounting plates, should insist that his engineers and designers familiarize themselves with the literature supplied by the manufacturers of these multiple hole punching systems. Such knowledge will pay off in lower piece part prices and reduced tooling costs.

Punch as many holes as possible in the flat blank. Save the drill jigs for close tolerance locations that must be drilled after forming or welding. Drilling is always an expensive operation. But where holes must be drilled, such as mounting holes and holes that must be drilled after assembly, it will be well to investigate the use of multiple head attachments. These heads fit standard drill presses and contain several collets, which are all driven from the same spindle. With these heads, the fabricator can accurately drill as many as a dozen holes through a drill jig at one time. Sheet metal designers should locate assembly holes, mounting holes or terminal locations so that such head attachments can be employed.

Another operation that increases production costs is the tapping of holes. Many times designers specify tapped holes even though thread cutting machine screws would do as well. The advantage to the purchaser of sheet metal fabrications using such screws is that the operation of moving the piece to the tapping machine is done away with.

Where a thread depth greater than the thickness of the metal is required, the use of spotweld nuts is an advantage. Such nuts can be installed when other spotwelding operations are performed and are still jigging.

Other mechanical means of obtaining threaded holes in a sheet metal part are internally threaded rivets and threaded inserts. They can be rapidly installed in the part either before or after assembly. Designers of sheet metal parts should weigh the advantages such items can offer against moving the part to and from the tapping machine.

From the preceding statements, it should not be construed that tapping in the conventional manner be abandoned. Another method, however, should not be overlooked when it best suits the type and requirement of a particular fabrication.

An example of lack of standardization is shown in Fig. 2, where both hole clusters are intended for the same type of tube socket. In the same project, Fig. 2(A) appeared on one drawing, and Fig. 2(B) appeared on three other drawings. The difference is in the screw clearance on the

satellite holes. For the same screw size, Fig. 2(A) calls for a 0.125 dia hole, while Fig. 2(B) calls for a 0.136 dia hole.

The fabricator read these two prints exactly in accordance with the specified dimensions, and included in his tooling costs the price of two punches and dies, which were identical in every dimension except for the screw clearance holes. If the designer had standardized on the clearance that would best fulfill his requirements, he would have saved several hundred dollars. Keep an eye on holes, they cost money.

A more costly example of where a standard should have been established as determined by assembly operations is shown in Fig. 3(A) and(B). These clusters of holes appeared on four different drawings, all on the same project. For mounting the components, the same size flat head machine screw is used in each instance. In each cluster, the satellite holes are 0.098 dia; there is a variation only in the diameter of countersink.

In assembly, the adaptor ring shown in Fig. 3(C) mates with the same hole clusters shown in Fig. 3(A) and (B). Note the discrepancy that probably could have been avoided. The satellite holes in Fig. 3(A) and (B) are 0.098 dia, while those in Fig. 3(C) are 0.110 dia. Assuming that the same clearance would be acceptable in all parts, one punch and die could be used to pierce all three clusters.

The savings in the ptice of punches and dies, coupled with the direct savings in drill press time by using a common countersink specification, could easily amount to a thousand dollars on a production run of ten thousand pieces.

Another example of lack of standardization that resulted in needless cost in tooling, set-up, and production time is shown in Fig. 4. The rectangular hole with corner fillets in Fig. 4(A) and the one with sharp corners in Fig. 4(B) were used for the same purpose on the same project. One appeared on one print, the other on two other prints. The only difference in the holes is the treatment of the corners of the rectangle. This lack of standard hole specifications resulted in two tools where one would have sufficed, additional set-ups and machine down time, and additional handling in production; all of which added to a higher piece part price.

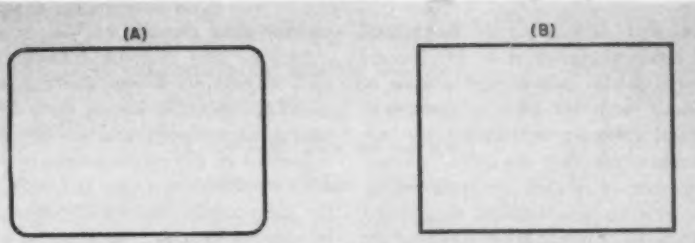


Fig. 4—Specifications of one rectangular hole with filleted corners and one with sharp corners resulted in needless cost in tooling, set-up and production.

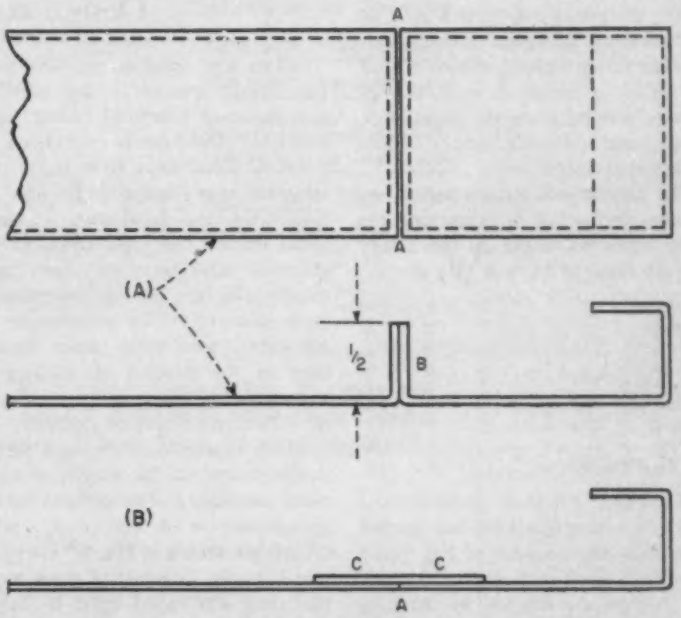


Fig. 5—(A) Formed flanges present a joint of smooth radii. (B) For a quality finish, this welded joint must be ground and sanded to get a smooth surface.

In closing the discussion of hole specifications, a comment is in order on the use of letter designations on drawings to indicate hole sizes, especially where a number of drawings are used to cover a given project. If, for instance, the letter "A" is employed to designate a $\frac{1}{2}$ in. hole and letter "B" to indicate a $\frac{1}{4}$ in. hole on one drawing, then these designations should be carried out on all drawings in the project. Switching designations from one drawing to another only causes confusion. This comment also applies to hole cluster designations.

Design to Avoid Grinding

In the design of sheet metal items, such as electronic consoles, power control racks, relay cabinets, and large terminal housings that compete in appearance with office equipment, remember that function should be wedded with eye appeal. When the seams and joints of sheet metal fabrications must be closed for acceptable appearance, the design often calls for welded joints that must be ground and sanded to present an unbroken surface. This is a good but expensive way to treat a joint for the sake of appearance.

In the joint shown in Fig. 5(A), both the cross tie and the panel are

fabricated with a return flange and are joined along line *A-A*. The formed flanges at this line present a joint of smooth radii that takes advantage of natural contours to enhance the appearance of the assembly. These parts can be joined by spotwelding, arc welding, gas welding or riveting without any concern about finishing the joint further.

One common way to assemble a cross tie and panel is shown in Fig. 5(B); the pieces are secured at *C* by spotwelding. This joint does not have a finished appearance. Where a quality finish is required, such a joint must be welded along the edges at *A*, then ground and sanded until a smooth surface is obtained.

The number of manufacturing operations performed in fabricating the components that make up the assemblies of Figs. 5(A) and (B) are:

Operation	(A)	(B)
Shearing	2	3
Notching	6	2
Forming	8	6
Spotwelding	1	2
Arc or gas welding	0	1
Grinding	0	1
Sanding	0	1
Total Operations	17	16

While 4 more notching operations and 2 more forming operations are needed to fabricate the assembly of Fig. 5(A) than the assembly of Fig. 5(B), the real savings are effected in reducing the number of handling operations by one and the spotwelding by half the number of spots, and in eliminating all gas or arc welding, grinding and sanding. These last three operations are costly and account for a decided difference in cost.

In addition to being less expensive to fabricate, the assembly of Fig. 5(A) has clean, natural lines and greater rigidity than the arc or gas welded assembly. This example demonstrates that it pays to design sanding and grinding operations out of sheet metal assemblies wherever practicable.

Instead of relying on a mass of material to achieve strength and stiffness, the same results can often be obtained by forming light gage sheet metal with corrugations, bulges and stiffening flanges. Light gage metal is strongly recommended to obtain better styling, easier handling, easier forming, greater use of spotwelding, and a more complete utilization of the facilities found in sheet metal fabrication shops. Heavy plate and angle construction requires more man-power, special handling devices, and the more expensive arc or gas welding operations.

Design to Trim Weight

When the function of the sheet fabrication demands heavy construction to avoid structural failure, light materials should not be considered.

In the trend away from heavy construction, new design techniques are influencing the fabrication of sheet metal items. The exploitation of the potential advantages of these techniques calls for: (1) Ingenuity in design; and (2) The cooperation of fabricators who have expert knowledge of the relation of forming to the strength, stiffness and performance of a sheet metal part or assembly.

Much can be done through proper design to reduce the weight of sheet metal assemblies. Two designs for the construction of the corner of a large cabinet are shown in Fig. 6. These are case histories in which a sheet metal fabricator was called upon to design and build an enclosure for an electronic assembly.

The construction shown in Fig. 6(A) is typical of that used in the power and electronics fields for many years. The corner is constructed by lapping a $\frac{1}{8}$ in. plate over another at 90 deg; to this corner is added a 2 x 2 x $\frac{1}{4}$ in. angle iron. The joint lines at *"A"* are then arc or gas welded, with the outside lap joint of the plates being welded the entire length of the structure, in this instance more than 80 in. The angle is often riveted into position; if so, the construction calls for drilled countersunk holes. The outside seam of the welded and riveted assembly is ground and then sanded to obtain a smooth corner.

The costly and heavy construction shown in Fig. 6(A) is stiff, but no more so than the corner fabricated as shown in Fig. 6(B). Here the rear panels and sides are segmented and flanged. The corner post consists of a part with two flanges and a corner bend plus a flanged reinforcing member, which is formed at three points and spotwelded in position. The corner post assembly and the panels are 16 gage cold rolled sheet steel.

The rear and side panels are welded into an assembly at points *"B"* with the gas shielded electric arc process, but could have been joined with the conventional electric arc or with a gun type spotwelder. Gas shielded electric arc does away with all spatter and the resultant chipping and clean-up, thus further cutting cost of construction. The resulting fabrication had more strength and stiffness than was required.

If constructed as shown in Fig. 6(A), the cabinet would have weighed 450 lb. As redesigned, Fig. 6(B), it weighed approximately 200 lb. Other benefits derived from the redesign were: better eye appeal, no distortion from welding heat, no costly grinding and sanding operations, easier handling of parts, more comprehensive utilization of facilities common to most sheet metal fabricators.

Old fashioned fabrication methods are outmoded. Proper design will enhance function and appearance and keep the dollar sign in mind.

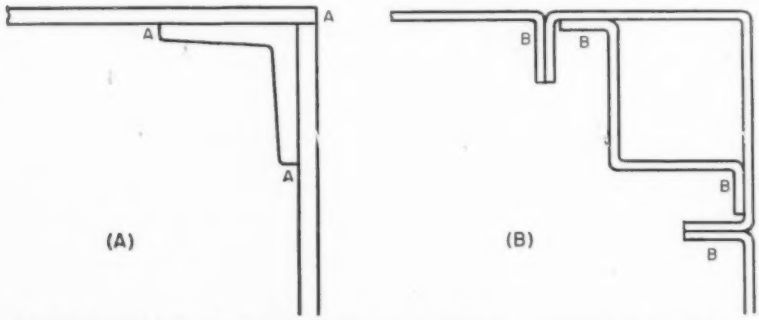
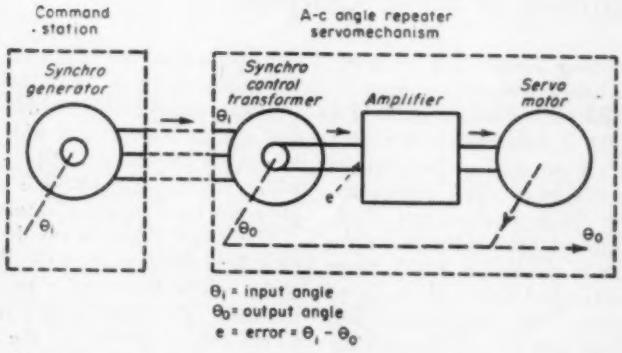


Fig. 6—Two designs of corner construction. (A) Heavy construction in which the outside seam is welded the entire length of the structure. (B) Equivalent light gage sheet metal construction weighs 250 lb less and installation in field is simpler.

Servo Damping Techniques

JULIUS Y. KAPLAN, ARMA CORPORATION



Control transformer delivers an error signal proportional to difference between generator and motor position. This signal is amplified and drives the motor so that input equals output.

SINCE SERVO SYSTEMS oscillate because of the interchange of stored energy between an electromechanical spring and a mechanical inertia, they can be stabilized by dissipating this stored energy. For example, coulomb friction can be applied so that the energy is dissipated in the form of heat. However, brute force is not essential for damping, and nonpower-consuming means can be used since damping can be supplied by any device that causes servo velocity and servo error to reach zero simultaneously after the system has been disturbed from its synchronized position.

A typical servomechanism, such as shown in the accompanying diagram, has spring-inertia characteristics similar to those of a vibratory system. The mechanical portion of the servo, consisting of the synchro, motor and gearing, can be assumed to be a pure inertia; and, since the correcting torque is proportional to error, a spring effect is introduced. Thus, the servo might be represented by an electromechanical torsion spring driving a pure inertia. After an initial displacement, this type of system will oscillate about the synchronized or zero torque position at a frequency that is proportional to the square root of the ratio of spring stiffness (torque divided by error) to system inertia.

Even though the average position of the servo is correct, these continued vibrations are usually objectionable. To counteract this condition, damping or stabilizing devices are used which permit the servo to acquire new headings rapidly and with a minimum of oscillations.

In undamped servos, there is no negative torque acting to decelerate the system until the error reverses, and as a result, the servo overshoots the zero torque position. What is required is a reversal in the net driving torque sufficiently in advance of the null to decelerate the servo to zero velocity at the instant the null is reached. Electrical damping devices of the nonpower-consuming type are commonly used in this application. These anticipate the null point with a proper torque reversal characteristic.

The amount of damping is instrumental in determining the response of a system. A critically damped servo, if subjected to a step positional input within the linear range of its components, will synchronize quickly with no overshoot. An underdamped servo will overshoot its null and hunt before coming to rest. An overdamped servo will not overshoot but will creep slowly into the null position.

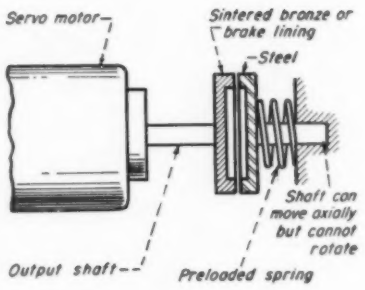
The following discussion covers several typical damping methods with emphasis on the merits and shortcomings of each. While these methods apply to the instrument type servo, they oer a cross-section of generalized damping devices used in a wide variety of servos. (*continued on next page*)

1. Mechanical Coulomb Friction Damping at Servo Output

Energy dissipation in each cycle of a servo oscillation is proportional to the coulomb friction output load. However, while damping can be improved by increasing the coulomb friction at the servo output, this improvement is only obtained at the price of an increase in static positional error. For example, a servo in synchronizing to a new command must develop sufficient torque to break the static friction. This torque can only be developed in response to an error signal. In the linear region, the error is proportional to the friction load so that with high coulomb damping a large error must occur before the servo will break loose.

For any given friction load it is not possible to reduce the static error without a deterioration damping. If the amplifier gain (ratio of output to signal voltage) is doubled, the servo spring constant (torque per unit error) will be doubled. Thus the energy storage is increased and the capacity of the same friction load to dissipate energy is proportionally decreased. Static friction also impairs the smoothness with which a servo will follow low constant velocity commands. An irratic following motion will result as the servo attempts to accommodate the abrupt changes back and forth from high static friction to low running friction.

Static friction exists to some degree in all servos but is usually kept small because of the static positional error and the poor following performance of the servo at low rates. Where coulomb damping is required, it can be approximated by using sintered bronze rubbing on steel as shown in the diagram. A hardened steel is normally used and the desired performance characteristics can be obtained by varying the pressure used in forming the sintered bronze. Hard brake lining material can be used in place of bronze.



In addition to the two inherent disadvantages of coulomb friction, mechanical damping also has the following limitations: it is difficult to obtain a low level of static friction; initial settings and field adjustments of spring loading are hard to make; damping varies with ambient temperature and humidity; and damping varies with wear particularly when the wear is not uniform.

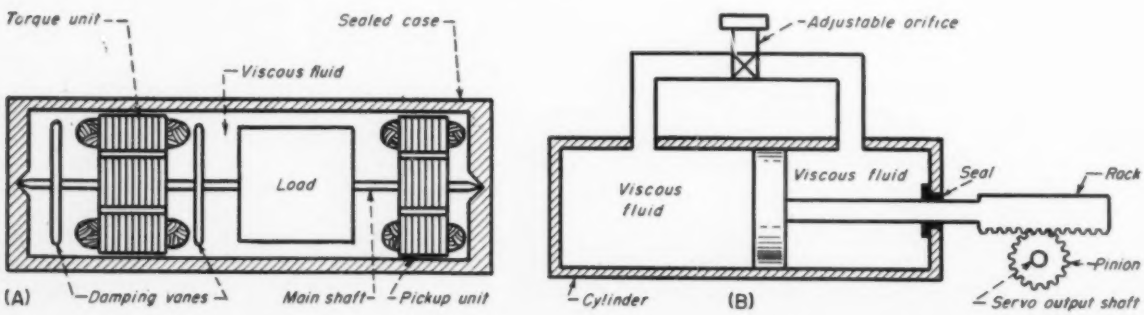
2. Fluid Viscous Friction Damping at Servo Output

Viscous friction is proportional to the velocity of motion and acts to oppose it. The damping of servo oscillations is accomplished through the dissipation of energy in the form of heat in the viscous damp. Mathematical treatment of viscous damping by linear theory is straightforward. Any degree of servo response can be obtained from the underdamped to the overdamped condition through the correct proportioning of viscous damping to servo spring stiffness and inertia. Such damping can cause no static positional servo error since there is no load torque when the unit is at rest. However, there will be an error proportional to the following velocity since a proportional torque must be developed to balance the friction drag.

If a disk on the output shaft of a servo (A) is immersed in a viscous fluid, a viscous drag proportional to velocity will be obtained. Recent applications have used silicone fluids with a high viscosity index since these fluids can be obtained in a wide range of viscosities and show little variation of viscosity with temperature. The unit shown here is a sealed assembly consisting of an input torque unit and an output pickup unit coupled to a load. It is used in certain types of computers. Although shown with two damping vanes, sufficient damping is often developed by the basic rotating elements without the special vanes.

Viscous damping units have the following limitations: it is difficult to seal against leaks over a wide range of ambient conditions; damping varies with temperature; and there is no simple means for damping adjustment.

The latter objection can be overcome by a device as shown in (B), in servos where the angular motion is restricted. The pinion shaft is coupled to the output member of the servo; usually to a low-speed, high-torque shaft since heavy forces are readily developed. The moving piston forces fluid through the adjustable orifice and is retarded. Damping can be varied by changing the restriction.



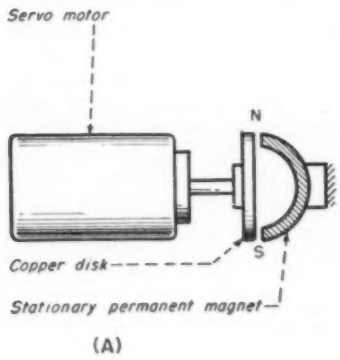
3. Electrical Viscous Friction Damping

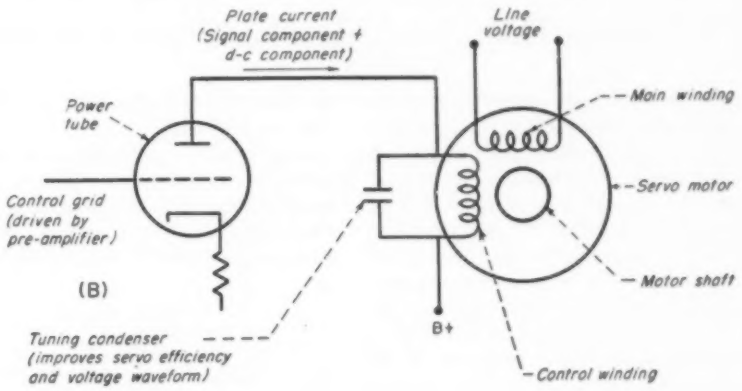
Eddy current damping is obtained by rotating a disk between the poles of a permanent magnet, (A). A drag torque, proportional to the speed of rotation, is produced between the rotating disk and the stationary magnet. Damping is difficult to adjust when a permanent magnet is used. The alternative is a d-c electromagnet. Drag is then proportional to current.

Variations of eddy current damping with temperature are primarily a result of changes in disk resistance. If there is a reasonable amount of damping at a normal temperature this change is usually not too important since present day magnets are essentially insensitive to temperature variation.

Where small amounts of drag are required, it is possible to obtain eddy current damping by passing d-c through the field of a two-phase servo motor. The d-c flux generates eddy currents in the squirrel cage, cup type or wound rotor of the servo motor. A convenient arrangement is to drive the control field of the motor directly from the single-ended output stage of a servo amplifier, (B). Here the d-c field is obtained from the $B+$ supply and together with the signal component makes up the plate current of the power tube.

If the d-c component is too large, there may be a serious heating problem or possibly saturation of the motor characteristic. The control winding must be well insulated from ground because of its high d-c potential.



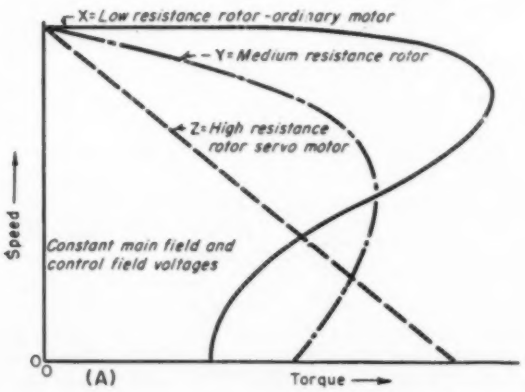


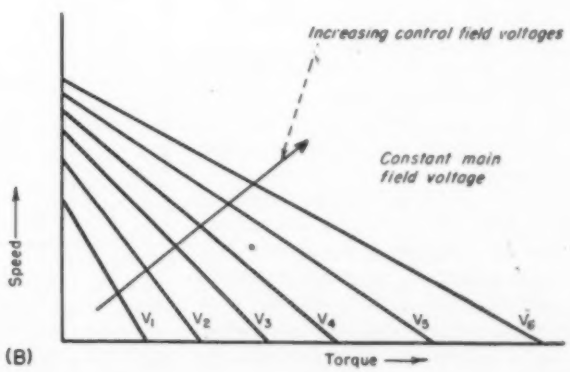
4. Viscous Damping Through Motor Characteristics

The two-phase induction motor used in a-c servomechanisms is designed so that its speed-torque characteristic will insure positive viscous type damping. This is accomplished by making the resistance of the rotor large compared to its inductance. The rotor may be a thin cup made of a low conductivity metal, a squirrel cage fabricated from metal bars or a laminated core with actual windings.

The variation of speed-torque characteristics with rotor resistance is shown in (A). These curves are for fixed main field and control field voltages. Curves X and Y are for induction motors with a low resistance rotor and medium resistance rotor respectively. Curve Z is for a typical servo motor with high rotor resistance. This characteristic is the same as that of a motor driving a viscous damping device that produces a drag torque proportional to speed.

The low speed region of curve X is unsatisfactory for servo use since an increase in torque with speed represents negative damping. With this condition there will be an even greater tendency to overshoot the null position





than if the motor showed no variation of torque with speed.

For different control field excitations, a family of curves (B) would result. If linear theory is used in the calculation of servo performance it is usually reasonable to assume two regions of operation; low voltage and high voltage. In the region of low control field voltage the effective viscous drag is usually about half that obtained in the high voltage region.

In the above discussion it has been assumed that the motor fields were excited from a constant voltage source. To obtain these results in an actual servo, a zero impedance driving source would be required. In effect, a well designed servo approximates this condition since a sizable amount of feedback from the output transformer is always used. Should the driving source present a high impedance, there is an increase in terminal voltage at the motor as the speed increases, since less current is supplied to the motor. This tends to make torque decrease less rapidly with speed, which means that the damping is not as effective.

There are three objections to the use of the various types of viscous output damping that have been covered: power is consumed in the process of damping and in following velocity commands, reducing the available torque; it is difficult to adjust the amount of damping; and proportional errors result from following velocity commands, even though there are no static positional errors. Other damping means are described later that will overcome these objections.

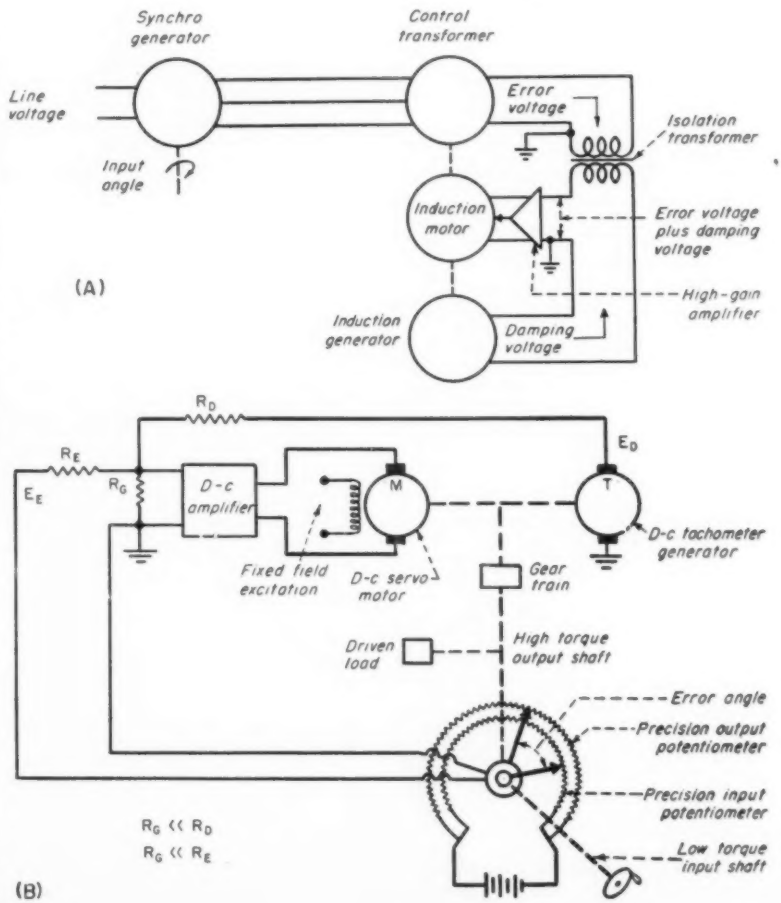
5. Viscous Damping Using Tachometer Generators

By the use of electrical feedback methods it is possible to obtain viscous type output damping without expending power. If a voltage proportional to the velocity of the servo, but of opposite polarity to the motoring voltage, is applied to the input of the servo amplifier, a proportional torque will be developed that opposes the driving torque. This is effectively a viscous drag torque produced by the motor in response to an order injected into the null circuit. This order can be obtained from a-c or d-c tachometer generators, geared to the servo output.

In (A) is shown a servo loop using an a-c induction generator tachometer to supply velocity damping. Error voltage and damping voltage are added by series addition. The use of the isolating transformer permits grounding of both the control transformer and the induction generator. Generator linearity is not important, except where the accurate compensation of velocity errors is required. In-phase carrier frequency voltage output at zero speed must be kept small to prevent static positional errors. Zero speed output of harmonic and out-of-phase voltage must be limited to prevent amplifier saturation. The phase of the speed voltage must be kept to a reasonable tolerance for the same reason.

A d-c servo system with tachometer damping is shown in (B). The tachometer damping voltage, E_D, and the servo error voltage, E_E, are added by parallel addition. This permits both the error and damping circuits to be simultaneously grounded. The resistors R_E, R_D, and R_G constitute the parallel addition network.

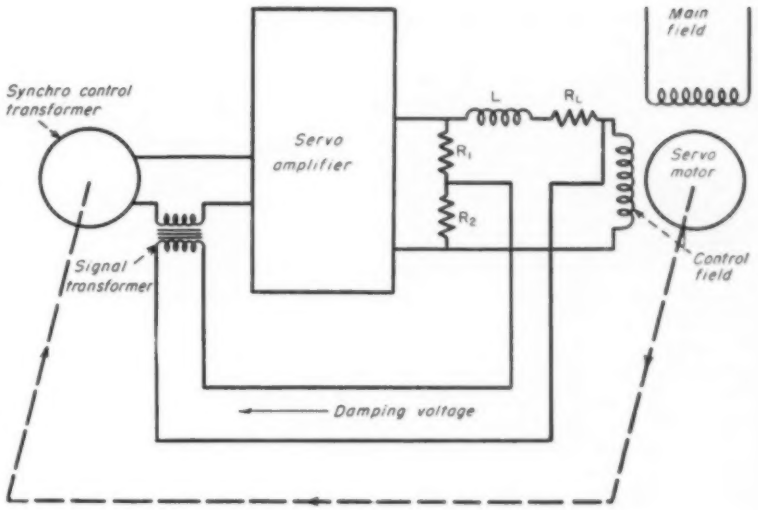
Good mechanical coupling of the tachometer to the servo motor is required. Preferably this should be a direct coupling although a good gear mesh can be used. It is not desirable to run the tachometer at a speed much in excess of the motor since it is more difficult to maintain a good mechanical mesh and the reflected inertia of the tachometer to motor increases with the square of the gear ratio.



6. Bridge Network on Control Field of Servo Motor

In a two-phase servo motor, a voltage proportional to speed can be obtained by connecting the control field winding as one arm of a bridge network. The impedance of the control field is balanced by the coil L and R_L. Resistors R_1 and R_2 are adjusted to give zero voltage output from the bridge at zero speed. At any motor speed a damping voltage is developed that is proportional to speed.

This arrangement is simple and inexpensive, since no complicated components are required. However, it is only acceptable in low performance servos, since the impedance of the control field varies with speed; there is a large amount of noise in the output; and the bridge circuit is sensitive to changes in ambient temperature.

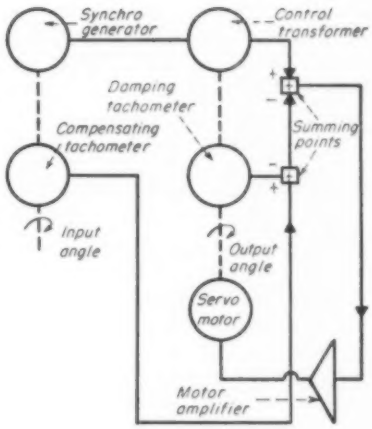


7. Full Compensation of Velocity Errors

In any viscous damping arrangement of the output or electrical feedback type there will be an error in the servo proportional to speed. In many servos this error is objectionable where accurate tracking is required. By introducing an opposing voltage proportional to the input speed, into the servo's null circuit, this error can be eliminated. With this arrangement, the response element does not supply the velocity voltage and damping is not affected.

In the diagram, velocity lag compensation is obtained from the compensating tachometer, driven at input speed. The tachometer signal voltage introduces an offset in the servo output that is equal and opposite to the velocity lag. Since the tachometer is not influenced by hunting of the output shaft, it does not affect stability.

This system is normally used only on large drives, since a separate servo or follow-up drive is usually required to drive the compensation tachometer from the synchro transmission electrical order. In addition, the accurate compensation of velocity errors requires close calibration, an investment that is not worthwhile in smaller, cheaper servos.

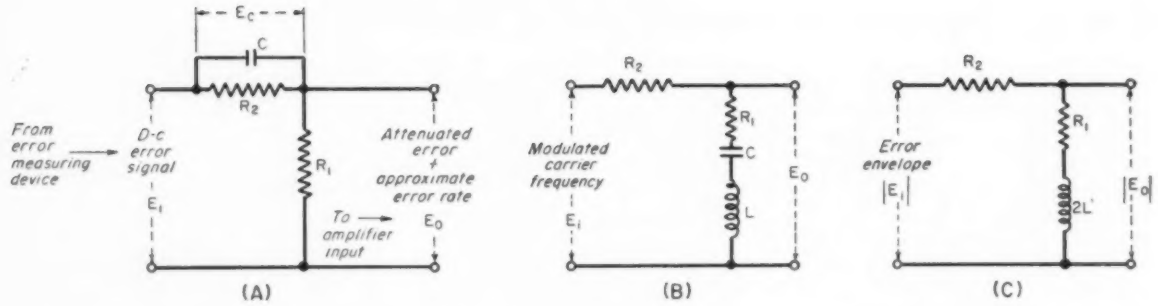


8. Error Rate Damping Methods

An inexpensive means of preventing velocity lag errors is to insert a suitable lead network between the error measuring device and the servo amplifier. These networks supply an electrical signal output that is approximately proportional to the time rate of change of the error as well as the error itself.

A typical d-c lead network is shown in (A). For a constant error signal the network merely attenuates the signal since the condenser remains charged at a fixed voltage. However, when the input signal is changing, the output signal changes more rapidly as a result of the charging or discharging effect of the condenser. For example, as the error signal, E_i, decreases, the condenser, C, discharges slowly through resistor R_2. This causes the voltages across the condenser E_c, to decrease more slowly than the input signal. However, the sum of the voltages, E_o, and E_c, must equal E_i, so that the output voltage, E_o, must decrease more rapidly than the input signal, thereby delivering a damping order to the servo motor.

This circuit only approximates a theoretical rate device since the network elements can only give an exponential response. The time constant of the network is the product R_2 times C. Error rate effect increases with this time constant. Longer time constants are required for sluggish (low frequency) servos, since greater anticipation is required.



Attenuation through the network usually varies from about 3:1 to 10:1. The damping effect increases with attenuation. Large attenuations are undesirable since the signal to noise ratio for this type of filter decreases with increasing attenuation.

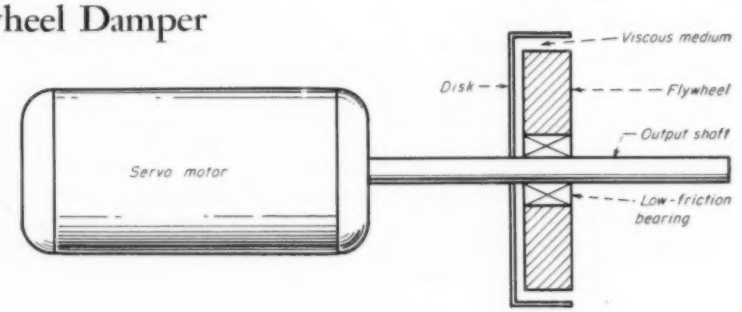
A d-c network such as this can be used on a-c servos if it is connected between a phase sensitive demodulator and modulator. While this is frequently done, a less expensive arrangement, (B), is available.

This resonant damping circuit can be placed directly in the error channel of an a-c servo if the inductor, L, and condenser, C, are tuned to the carrier frequency. Essentially an a-c servo is a carrier suppression system in which the components operate on sidebands. These sidebands are equidistant about the carrier, at a distance corresponding to the frequency at which the servo is operating. In this region the tuned circuit supplies a rapid change in phase shift which is responsible for its ability to give some form of rate output. The equivalent circuit of this device is shown in (C). In response to changes in the error signal, this network operates in a manner analogous to the d-c lead circuit. The time constant is proportional to the Q (ratio of L to R) of the coil and is equal to $2L/R$.

For high performance instrument servos, midget size damps with a Q of 20 are satisfactory. Lower performance (lower natural frequency) servos require resonant damps with a higher Q. These circuits can be accurately tuned and will maintain their setting over a wide range of ambient temperature variations. In d-c network, large attenuations are not practical because of the signal to noise ratio reduction.

The detuning effect with change in carrier frequency is a problem in all tuned circuit a-c damping networks. The reduction in damping is not as objectionable as the increase in out-of-phase voltage which can cause saturation of the servo. Methods for compensating for carrier frequency variations have been devised, but are only practical for larger systems.

9. Viscous Coupled Flywheel Damper



This output damping device gives an effect similar to error rate damping. A flywheel of inertia much larger than the servo motor is bearing mounted on the rotor shaft. A low inertia disk is rigidly connected to the rotor shaft adjacent to the flywheel. Viscous coupling is provided between the disk and the flywheel by magnetic or fluid means. Another type has spring as well as viscous coupling. This is used for damping at a specific frequency.

For a constant velocity motion of the servo, there is no relative motion between the flywheel and disk. However, when the system either accelerates or decelerates there is a viscous drag between the motor and flywheel. There is no velocity lag error and the damping equations of this output damp are in the same form as those of the error rate network discussed in 8. The damping time constant of this system is the ratio of flywheel inertia to viscous drag coefficient, and attenuation is ratio of motor inertia to total inertia of motor plus flywheel.

One advantage of this device is that it gives output damping without extracting power from the servo at constant velocity. However, the natural frequency of the servo is lowered by the heavy flywheel.

SELECTED REFERENCES

1. Lauer, Lesnick and Matson, *Servomechanism Fundamentals,* McGraw-Hill Book Co., New York.

2. W. J. Deershake and A. C. Hall, Instrument Servomechanisms Special Devices Center, Office of Naval Research, U. S. Navy NAV Exos P-536—U. S. Govt. Printing Office.

3. G. S. Brown and D. P. Campbell, *Principles of Servomechanisms,* Wiley and Sons, New York.

4. H. Chestnut and R. W. Mayer, *Servomechanisms and Regulating System Design,* Wiley and Sons, New York.

5. H. M. James, N. B. Nickols, R. S. Phillips, *Theory of Servomechanisms,* McGraw-Hill Book Co., New York.

6. M. F. Gardner and J. L. Barnes, *Transients in Linear Systems,* Wiley and Sons, New York.

7. D. McDonald, *Improvements in the characteristics of A. C. Lead Networks for Servomechanisms,* A.I.E.E. Tech. Paper 50-46, 1949.

8. A. M. Hopkins, *A Phase-Plane Approach to the Compensation of Saturating Servomechanisms,* A.I.E.E. Proceedings T1-103, 1951.

The Reader AUDITED PAID ABC CIRCULATION *His Mark*

THE ABC that appears in the symbol at the top of this page stands for Audit Bureau of Circulations. The symbol itself is an emblem of cooperation, in which every subscriber to this magazine has an interest.

The Audit Bureau of Circulations is a voluntary, non-profit, cooperative association. It was founded in 1914 and now consists of 3450 advertisers, advertising agencies and publishers in the United States and Canada. This magazine is proud to be a member.

ABC originally was set up to help take the racket out of publishing, to eliminate the waste and guesswork then so prevalent in publishing and advertising, to establish order and confidence in place of the misunderstanding and misrepresentation that arose from unverified circulation claims and dubious circulation practices. Its mission was to protect the interests of both readers and advertisers.

THIS IT DID by first defining the term "paid circulation." Then it established standards and rules to govern subscription sales practices and records. Finally it set up an auditing organization to verify the claims and report the facts concerning the circulation of each member publication. It now maintains on that job a working staff of sixty-five full-time auditors. So the ABC symbol has become the hallmark of circulation standards and advertising values. Each member publication must maintain those standards if it wishes to retain its membership and display the ABC symbol.

This ABC audit is no perfunctory affair. When a business publication, such as this one, becomes a member of the Bureau, it agrees that the auditors shall have "the right of access to all books and records." Their inspection, therefore, may cover any part of its operations. Original subscription orders, payments from subscribers, paper purchases, postal receipts, arrears of payments, and many more items are painstakingly checked by the auditors. In many instances they go behind the records to seek verification from subscribers themselves as to the terms of their subscriptions.

IN DOING ITS JOB, ABC has created many values for both publishers and readers as well as for advertisers. That is because the publication that becomes a member of ABC thereby offers the strongest possible guarantee of its primary devotion to the interests of its readers. The function of a business magazine is to be useful to its readers. When this service is rendered by an ABC publication, it is constantly subject to the practical test of reader acceptance and approval. As each subscriber has the right to purchase or refrain from purchasing an ABC publication, that collective right confers upon the readers the power to say whether or not the publication will survive. Thus the report on its ABC audit provides the most direct assurance that a publication stays in business only because of a voluntary demand by readers who find its editorial service responsive to their needs.

Naturally, the editor of each business publication follows closely the score thus racked up by his paper in its ABC reports. In the scope and tone of his editorial coverage and treatment, in the selection and presentation of his editorial content, he must constantly labor to maintain and enhance the readers' acceptance of his efforts. That is why the editorial standards established by ABC publications set the editorial standards for all publishing. That is how the ABC constantly stimulates its member publications to become even more useful to their readers.

AND THAT IS WHY the ABC symbol has become the Mark of the Reader, a constant reminder that his willingness to pay for an ABC publication is the acid test of its value both to him and to its advertisers.

McGraw-Hill Publishing Company

TECHNICAL NEWS

TURBOPROPS TO POWER TRANSPORTS

BRISTOL BRITTANIA, turbo-prop powered airliner, is forerunner of giant 100 passenger airplane currently under construction.

VICKERS VISCOUNT, powered by Rolls-Royce Dart turboprops, is currently a best seller in foreign markets.

WHEN British Overseas Airways Corporation (BOAC) inaugurated intercontinental jet passenger service last year, English aviation enthusiasts hailed the dawn of a jet transport era. Now they aren't so sure. According to *Aviation Week,* latest reports from Great Britain indicate that turbojet power for commercial aircraft is fast losing favor. Its replacement: turboprop units—gas turbines that drive propellers.

Privately, British observers are admitting that big commercial jet airplanes appeared prematurely. The major handicap has been excessive fuel consumption that skyrocketed operating costs and reduced flying range.

Driving force behind the change away from turbojets, surprisingly enough, is BOAC, who pioneered commercial jet service and has been its strongest proponent. Although they could boast of owning the fastest transports in passenger service, BOAC officials lost their enthusiasm watching fuel and maintenance costs eat up revenue.

BOAC's chairman, Sir Miles Thomas, voiced the new approach. He thinks that turboprops supply the best available answer for long distance civilian air transportation. New turboprop designs, he predicts, will be much more economical to operate—at least 50 per cent better than a jet engine on a mileage-per-gallon-per-ton-carried basis.

Although details are a closely guarded secret, it's known that BOAC's latest pet project is the "Super Brittania" being built by Bristol Aeroplane Company, Ltd. Heart of this 100 passenger luxury transport will be four twin-spool turboprop engines, each with an output rumored to be in excess of 5,000 eshp.

Development work throughout the aircraft industry shows the influence of this change. At least three of England's major engine builders have new turboprop engines under design. De Havilland, designer and builder of the Comet jet-series, is sounding out customers on the desirability of powering the proposed Comet Four with turboprops instead of turbojets. Three companies—Hamilton Standard, Aeroproducts, and Curtiss Wright—are working to evolve high speed propellers that will operate at speeds up to 500 mph.

However, along with the advantages of better economy, less noise, and reduced maintenance, the airlines will have to face up to certain disadvantages inherent with turboprop power plants: maximum speed will be cut about 100 mph; propeller-driven flight will not be as smooth as jet, nor can it take place at such high altitudes.

Further confirmation of the new preference comes from two other sources:

• 1) American airframe manufacturers say that the turboprop-powered

Viscount Vickers has become their stiffest competition for foreign markets. Until recently, de Havilland's Comets had the inside track.

• 2) Lockheed Aircraft Corporation reports that spurting sales of their Super Constellations, equipped with Wright turbo-compound engines, has built the biggest order backlog for commercial planes in the company's history—$150,000,000.

Lockheed also reveals that deliveries of Super Constellations scheduled to foreign airlines in the remainder of 1953 will total 40 percent more than the combined export of large aircraft by all American companies in 1952.

NEW PRODUCT IDEAS

GOVERNMENT PATENT GROUPS are offering a one dollar bargain to small manufacturers who are looking for new product ideas. A 168 page book, "Government Owned Inventions Available for License", just published by the Department of Commerce, lists 3,658 U. S. owned patents according to fields of industrial use. There are 20 major classifications, subdivided into 211 sub groups.

Such a voluminous compilation testifies to the quantity of government research and development, tremendously accelerated in the past 15 years. Of the patents listed, 1,709 resulted from the work of government employees, 1,949 from employees of government contractors. Dr. Archie Palmer, chairman of the Government Patents Board under whose direction the book was edited, pointed out that usually these inventions are available on a royalty-free basis (though the user must apply for a patent license). He observed that many significant developments are included in the list. For example:

• Magnetic Fluid Clutch (Nos. 2,575,360 and 2,622,713; invented by Jacob Rabinow for the Army).

• Ceramic coatings to protect materials from high temperature corrosion (Nos. 2,475,469 and 2,475,470; invented by D. G. Bennett and C. M. Andrews for the Air Force).

Copies of the book may be purchased (price $1.00) at field offices of the Department of Commerce, field offices of the Small Business Administration, or directly from the Government Printing Office, Washington 25.

CURTIS W. McGRAW DIES

ON SEPTEMBER 10, Curtis Whittlesey McGraw, president and chairman of the Board of the McGraw-Hill Publishing Company, died in his sleep at the Carlyle Hotel, New York City. He was 57 years old.

Mr. McGraw, whose home was at Princeton, N. J., was the third son of the late James H. McGraw, Sr., founder of the publishing company of which Curtis McGraw had been president for the past three-and-a-half years, and of Mrs. Mildred Whittlesey McGraw of Madison, N. J., who survives him. His wife, the former Elizabeth Woodwell of Princeton, a daughter, Mrs. James L. Stoltzfus of Lake Forest, Ill., and three brothers, Harold W. McGraw, James H. McGraw, Jr., and Donald C. McGraw, also survive.

Born in Madison, N. J., Oct. 13, 1895, Mr. McGraw was a graduate of the Lawrenceville School, Lawrenceville, N. J., and of Princeton University, class of 1919. At Princeton, he was president of his freshman class, captain of his varsity football team in 1919 and was active in basketball and other sports.

He was a major of infantry in World War I and saw foreign service in the Artois Sector and Meuse Argonne Offensive.

Mr. McGraw was active in numerous civic affairs, and was a member of the Postmaster General's recently appointed Advisory Board of the Post Office Department. He was a past director and past president of the American Book Publisher's Council.

He was also director of the First National Bank of Princeton, the Dragon Cement Company, the Princeton University Press, of which he was treasurer, the Princeton Hospital, of which he was president, and the Magazine Publishers' Association. He served as a member of the Princeton Zoning Board from 1919 to 1952.

He became vice-president and treasurer of the McGraw-Hill Publishing Company in 1943, and in February 1950, was elected president and chairman of the Board.

1953 Metals Show

WHEN THE THOUSANDS of visitors expected at the 35th National Metal Congress and Exposition (October 19 to 23) arrive in Cleveland, they will all have at least one interest in common: they'll be looking for ways to reduce production costs. The theme of this year's show—"Metals Market Place of the World"—doesn't tell the whole story; the exhibit emphasis will be on metal working processes, equipment and components.

By examining the metal supply picture you can see the reason for the shift in interest. The era of shortages is over. At recent shows, metals have been scarce, and visitors spent most of their time looking for material substitutes. Three years ago everything was hard to get; two years ago there was a slight improvement; last year as many metals were available as were in short supply; and this year only the exceedingly rare and infrequently used materials are on the critical list. Interest in materials is not vigorous.

It poses a challenge for metal suppliers. Those who exhibit at the show will be pushing new uses for old "reliable" metals.

•

There are also some changes in the economic picture that help put the premium on efficient, low cost production. The end of the Korean War and the tapering off of military spending has brought back old time competitive selling. In such a situation companies try to keep prices down and to hold on to their traditional share of the market. That means they are reluctant to raise prices even though profit margins are squeezed by high labor costs, continued high taxes, and higher overhead charges. The answer, according to many people, is to squeeze the fat out of production—to cut costs, to increase production speed, and to reduce labor requirements.

Many exhibitors will claim that they have the answers to such problems. For instance there will be a lot of talk about automation. One electrical manufacturer will display a new x-ray Productograph for conveyor line inspection of castings. Another will have a new automatic stud welder. A third will emphasize high speed brazing operations.

Welding and other fastening operations will be the center of a lot of attraction because joining is a process that lends itself to automatic production. Several companies plan to present new automatic setups and machines.

•

Technical sessions will be broken up into four groups, each run by one of the show's sponsors. The American Society of Metals will hold their meetings at the Hotel Statler; The American Welding Society at the Hotel Cleveland; the American Institute of Mining and Metallurgical Engineers at the Allerton Hotel; and the Society of Non-Destructive Testing at the Hotel Hollenden. All four groups will spend large amounts of time discussing titanium, indicating that this metal still commands a lot of attention.

On the ASM program are sessions covering titanium, boron, and stainless and high speed steels. These are typical highlights: Heat Treatment of High-strength, Titanium-Base Alloys; The Effect of Boron on Notch Toughness and Temper Embrittlement; Notched Bar Tensile Strength of Various Materials.

AWS members will hear such papers as these: Automatic Flame Cutting for Machinery Weldments; Resistance Welding in Jet Engine Manufacture; Silver Brazing Alloys for Corrosion Resistant Joints in Stainless Steel; Fusion Welding Pure Titanium; Soldering Aluminum; Tolerances on Fillet Welds.

The AIME plans sessions to discuss plastic deformation, metallography and physical metallurgy, the latter particularly as affecting titanium.

TITANIUM PARTS . . .

. . . cast in a vacuum arc furnace by a new method that permits turning out pieces weighing up to several pounds with carbon, oxygen and nitrogen content reasonably comparable to that in commercial wrought metal. Key development in this National Research Corporation process is a special mold material that withstands attack by molten titanium. The technique works equally well with either the pure or alloyed metal.

CHROME CARBIDE GAGE BLOCKS

CHROME CARBIDE, new material that augments the tungsten carbide family (*Product Engineering*—August, 1953, p 154), has turned up in ultra precise gage blocks that permit accuracy unattainable with steel blocks. The Webber Gage Company reports corrosion resistance—up to 30 times greater than other carbides and ten times greater than 18-8 stainless steel—and abrasion resistance is such that blocks made from the new materials last almost fifty times as long as steel ones currently in use.

According to Webber, the main limitation of steel blocks is the surface finish that can be applied. Steel units have to be polished on a soft lap because a hard lap abrades the surface ruining the finish. Chrome carbide, on the other hand, can be polished much more smoothly because the material has a fine grain structure and is extremely hard.

Because of the high polish on

chrome carbide blocks, the wring factor—a measure of the force by which two highly polished surfaces cling together—is negligible.

To check the increased degree of accuracy of these new blocks, Webber is using a specially designed interferometer, the only one of its type in the United States. Built by the Zeiss Optical Works in Western Germany, the device is capable of measuring surface finish within plus or minus one ten-millionths of an inch.

TUNGSTEN INSTITUTE FORMED

SINCE DEFENSE REQUIREMENTS for tungsten have passed their peak, American companies mining the metal have formed their own association to promote peace time uses. Representing four-fifths of American Tungsten production*, the group will be known as the Tungsten Institute.

The group's first president, W. Lunsford Long, (Vice President and General Counsel of the Tungsten Mining Corporation) has announced these objectives: 1) to encourage the development of the tungsten mining industry; 2) to encourage progress in the metallurgy of the metal; 3) to promote the use of the metal; and 4) to supply an industry spokesman who can present a united front in dealing with government matters.

James A. White, elected Executive Secretary and Treasurer, will be in Charge of the Washington (D. C.) office at 1757 K Street, N. W.

FELT STANDARD SAMPLE FILE

MANUFACTURING MEMBERS of the Felt Association are filing standard samples in a display which will be open to the public at all times at the Association's offices, 74 Trinity Place, New York City. These samples cover the specifications of the Felt Association, the U. S. Department of Commerce CS 185-53, the Society of Automotive Engineers, the American Society of Testing Materials, the American Society of Mechanical Engineers and the military specifications of the Army, Navy and Air Corps.

In the mechanical roll felt classification the five standard densities are set up to show the differences in physical and chemical characteristics. They include the trade designations known as: Laundry, Backcheck, Ball-Bearing, Firm Pad and Extra Firm Pad, Lining, Soft Pad. The samples mounted on cards measure 5 in. x 9⅛ in., a technical size, convenient for checking weights on a gram scale for direct conversion to oz. per square yard.

** But last year, U. S. miners produced only twenty percent of the free world's tungsten. China, with the world's biggest known reserves, was the largest supplier until the Communists seized political control and diverted production to the U. S. S. R.*

3,400 GAL TRUCK TANK molded from glass reinforced polyester resin is the biggest such unit ever built. It presages a . . .

. . . PLASTIC TANK TREND

PLASTIC MOLDERS are aiming to corner a share of the road tank market which, up to recently, was exclusively in the hands of steel fabricators. Last month, a 3,400 gal, chemical-hauling plastic tank—biggest ever built—made its debut. One trucking official who looked the unit over thought it marked the start of a new trend in such equipment.

There's some past experience to back this up. Several smaller truck models have been in operation for over a year, hauling fuel and water in mid-eastern deserts. They have stood up well despite temperature extremes and exposure to sand erosion.

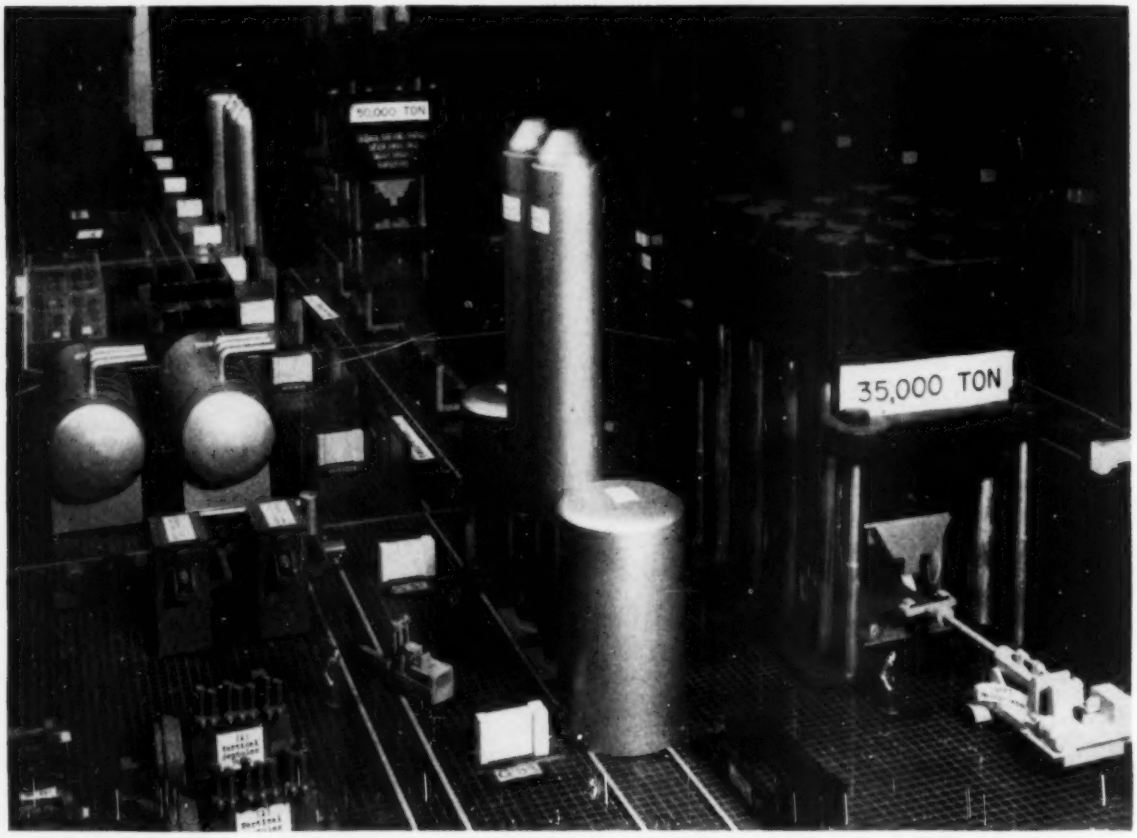
The main advantages of plastics tanks appear to be (1) reduced fabricating costs and (2) the fact that their low weight permits bigger payloads. The big unit (shown above) was produced by a two stage molding method that needs no pressure equipment. Molded components were formed by combining American Cyanamid's polyester resin, a catalyzing agent for curing, and layers of glass fiber mat and roving over a wood mold. Six such molded sections were assembled, rewound with glass fiber material, reimpregnated with resin to form the big tank—over 21 ft. long, six ft wide, and four ft high.

However, future versions will be essentially of one-piece construction formed over an inexpensive mandrel, so says the fabricator, Carl N. Beetle Plastics Corporation. Because the plastic units need no chemical-resistant lining, units made this way would cost only one-third as much as stainless steel tanks.

Fully equipped and mounted on a trailer, the new oval shaped tank weighs only 7,025 lb. That's 3,600 lb less than the steel tank it replaces. It means the plastic tank can haul 33 percent more fluid without exceeding over-the-road poundage limitations.

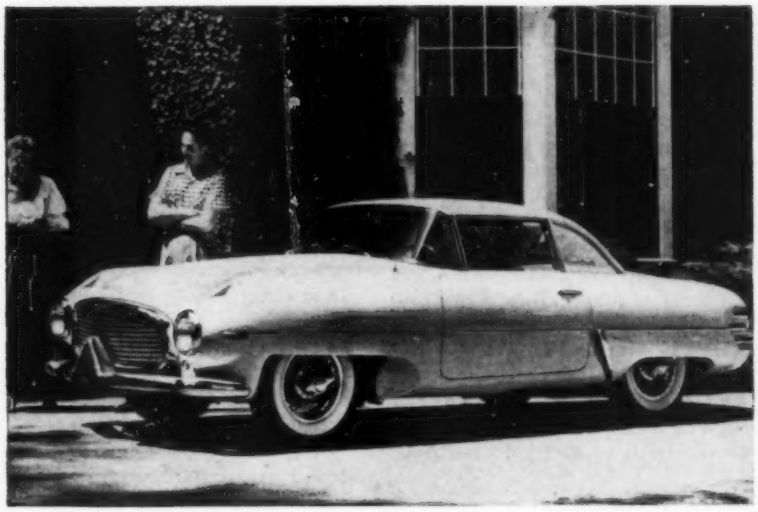
Even though the unit is lighter, it maintains relatively high strength.

THE NEWS IN PICTURES



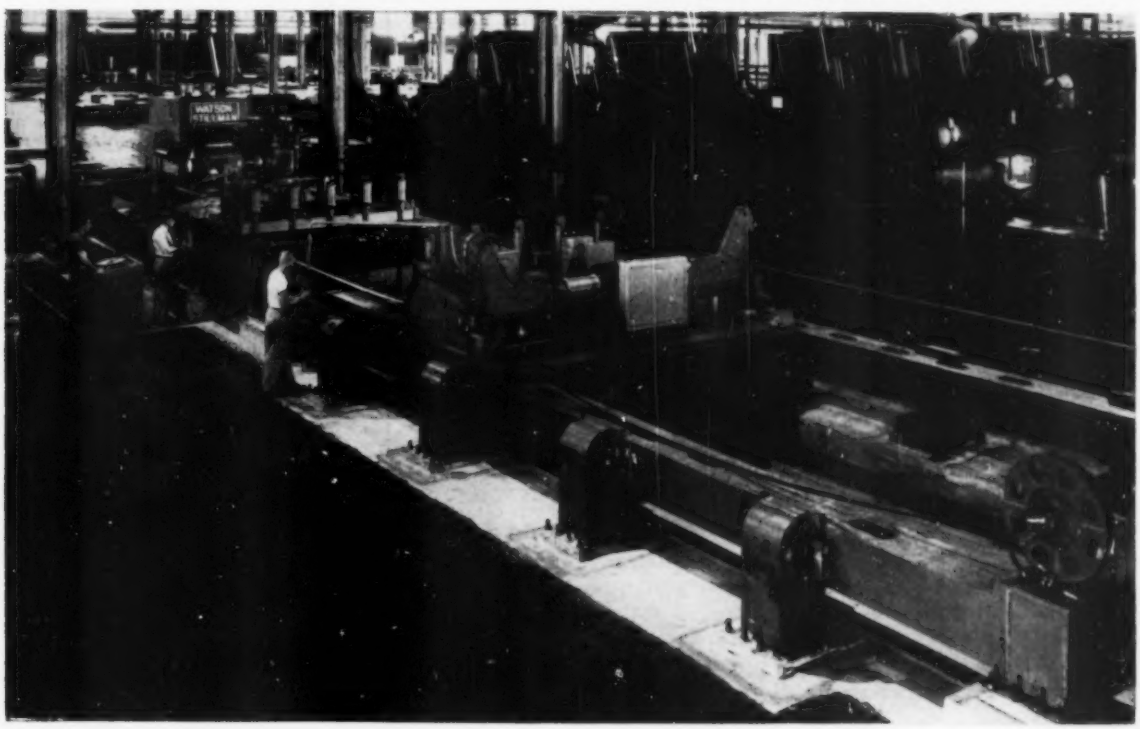
SCALE MODEL of the new Air Force Heavy Press Plant at Cleveland, Ohio, was built by Aluminum Company of America so engineers could study and experiment with plant layout. The completed installation will house two of the largest metal working presses in the world—35,000 and 50,000 ton capacity. Among the major problems solved with the $6,500 model: where to locate forging furnaces so ingots can be moved easily and quickly to the presses with minimum loss of heat.

THIS ELECTRON SCATTERING APPARATUS gave Stanford University scientists the closest look at the nucleus that man has been able to manage. High speed electrons from Stanford's linear accelerator entered the drum-like chamber and passed through nuclei of various target metals, being scattered out glass window by nuclear particles into significant patterns. By examining such patterns, scientists have developed a new concept of the nucleus; they no longer believe it is a solid ball of uniformly-packed particles, but rather a "cottony" sphere growing denser at the core.



NEWEST IDEA of what the car of tomorrow will look like is the Italia, designed by the Hudson Motor Car Company. A small automobile—10 in. lower than the standard Hudson and with a wheelbase of only 104 in.—it is powered by a 114 hp Hudson "Jet" engine. Three significant body features: flat roof design with door opening into the roof; air scoops built into front fenders, just above headlights; and rear lights placed in a triple bank of chromium tubes. Stylist for this design was Carrozzeria Touring, Milan, Italy. Inside the Italia (at right) are two individually adjustable seats with reclined backs, shaped to fit shoulder, back and hip contour.

MOST POWERFUL STRETCHER in the world—5,000,000 lb capacity—has been installed at Kaiser Aluminum's Trentwood plant. Through accurately controlled stretching, the machine flattens aluminum plate and relieves residual stresses resulting from rolling and heat treatment. Uniform strain can be exerted over plate up to 2 in thick and 40 ft long instead of progressive working of local areas done by other methods of flattening. Machine, which is hydraulically operated, extends eighty-one ft in its overall length, is eighteen ft wide, and reaches nine ft tall at its highest point. It weighs over 275 tons.



OPERATION TINKERTOY

THE AUTOMATIC FACTORY, where machines replace men, came one step closer to being a reality last month when the National Bureau of Standards and the Navy Bureau of Aeronautics lifted the secrecy veil from Operation Tinkertoy. Behind the curtain NBS had developed a system—and equipment—for the mechanized production of electronic equipment. The Bureau built a pilot plant that fabricates electronic assemblies by mechanical means; now a civilian contractor is operating the plant as part of a large-scale evaluation program.

There are two major phases of Operation Tinkertoy (see boxes):

(1) Mechanized Production of Electronics (MPE), a production system that uses automatic fabrication and assembly equipment.

(2) Modular Design of Electronics (MDE), a compatible general system of electronic equipment designs using a modular concept. Both are based on exploitation of the latest printed circuit techniques—using conducting paint for wires, thin ceramic capacitors, adhesive tape resistors and automatic dip soldering.

Bureau scientists claim the key to automatic production of electronic gear was MDE. The system establishes a series of mechanically standardized and uniform modules or building blocks, reproducible within a wide range of electrical characteristics.

Each module consists of four to six thin ceramic wafers, bearing various circuits associated with an electronic stage. A number of modules are combined to form a major sub assembly. Once designed according to MDE techniques, a component can be turned out, in quantity, automatically. One of the most advanced automation projects ever conceived, here's what MPE equipment does—automatically:

- Makes ceramic wafers—$\frac{7}{8}$ in. sq by $\frac{1}{16}$ in. thick—in quantity directly from raw materials.
- Produces ceramic capacitors in the same way.
- Produces adhesive tape resistors.
- Prints appropriate circuits, the proper configuration being achieved through photographic processing.
- Inspects every stage for mechanical and electrical characteristics. Inspection being directed by information supplied on punched cards.

The concept behind MPE: turn bulk or semi-processed materials into finished electronic gear. The pilot plant, capable of producing 1,000 modules an hour, produces all large quantity parts except the vacuum tubes.

Operation Tinkertoy's successful culmination opens up a new vista for industrial preparedness. One of the most significant features of the development is that it permits practically instantaneous changeover from civilian production to military items.

Government planners see two production bottlenecks wiped out by the program: (1) lead time for the production of military electronics can be cut 75 percent since component parts are made directly from bulk materials. (2) Reduces sharply the number of trained production personnel required. The system depends for experience and knowledge on machines rather than humans.

One of the most intriguing possibilities is the fact that both military and civilian components can be produced on the same machines, and the ratio of such output can be varied.

Performance of equipment produced by the machines appears generally equivalent to that obtainable from conventional hand assemblies. Equipments, produced to date, meet military environmental requirements, passing such tests as shock, vibration, temperature, and humidity. Experience indicates that the mechanized production line turns out more uniformly acceptable equipment because of the automatic testing at every phase.

Modular Design of Electronics

In MDE, product flexibility is combined with general characteristics of conventional assembly methods. Product standardization and uniformity—prerequisites for economical processing by automatic machinery—are also integral aspects of the system.

Interconnection between any number of modular systems is relatively simple. By combining modular assemblies containing different components (such as resistors, capacitors, and coils), whole electronic circuits are developed to amplify signals, generate and shape wave forms, scale count, and perform other electronic functions.

MDE does not use a conventional circuit diagram of the tested electronic model. Instead, it places all necessary production programming information on an MDE work sheet. This sheet contains the front and back outlines of six wafers, each riser wire, and the electronic piece that is to be placed on the wafer. To translate a conventional wiring diagram to a MDE sheet:

(1) The engineer indicates the position of the electronic piece, its proper value and tolerances.

(2) He then draws lines to indicate how the circuits between wafers are to be connected.

The work sheet becomes the basic document from which a draftsman makes an ink drawing that can be reproduced in large numbers. The draftsman also prepares a larger version of the work sheet that is photographed and is used to make stencils for the circuit printing machines. The number of wafers and tube sockets listed on the MDE sheets tell how much raw ceramic materials must be mixed. The number and value of resistors marked on the work sheets determine the tape resistor production.

There's one other use for the MDE work sheet: it helps establish the inspection procedure. Current paths on each wafer are marked on specially prepared punch cards that accompany the wafers through all of the manufacturing processes. The sheet is also used in the construction of the standard modules or counterparts that are used in the final testing and inspection of the module assembly.

Mechanized Production of Electronics

MPE consists of the mechanized production of ceramic wafers, titanate capacitors and tape resistors, and their automatic assembly and testing.

Wafer Production: The wafers and tube sockets are made from a controlled combination of talc (actually a very pure form of face powder), kaolin, and barium carbonate. After being mixed, filtered and dried to a powder, the mineral mixture is loaded into a mechanical device that presses out the wafers or tube sockets and cuts the riser wire notches. The wafers are cured in a tunnel kiln operating at 2,300 F. After curing they are mechanically gaged and all pieces that that do not fit close tolerances are rejected. The press can produce up to 2,800 pieces per hr; curing takes about nine hours.

Component Production: Manufacture of the titanate capacitor closely resembles procedures for the wafers. The material is a nonporous ceramic composed of magnesium, barium, calcium and strontium titanates of high purity. The finished capacitor is about $\frac{1}{2}$ in. sq and 2/100 in. thick. Capacitance values vary from 7.0 mmf to 0.01 mf. Five pounds of raw material will turn out almost 100,000 capacitors, 80 percent of which will pass inspection.

To make tape resistors, these materials are needed: Quinterra (a heat resistant asbestos paper tape), polyethylene tape, carbon black or graphite, resin and a solvent. The manufacturing steps: (1) The resistor formulation—consisting of carbon, resin and solvent—is ground to a fine adhesive powder. (2) It is sprayed on a loop of Quinterra tape. (3) A protective coating of polyethylene tape is applied over the resistor compound immediately after spraying. (4) The tape is split into five or six narrow strips and stored on rolls.

Seventy-five feet of tape will produce over 10,000 resistors, ranging from 10 ohms to 10 meghoms. They will hold their rated resistance within ±10 percent up to 400 F, dissipating $\frac{1}{4}$ watt power at the operating temperature.

Metallizing: Appropriate sections of the wafer or capacitor body are silver painted, cured in a furnace and then inspected—all operations are mechanized. In this way, circuits are printed on the wafers, notches are coated, conducting leads are applied to capacitors.

Components Assembly: After the wafers and capacitors have been made and metallized, they are joined together. Machines apply as many as two capacitors to each side of a wafer. Other machines put either one or two tape resistors on each side of a wafer. Using rolls of resistor tape as raw material, the machine automatically cuts the tape into $\frac{1}{2}$ in. lengths, presses the tape between electrodes printed on the wafer, applies pressure and ejects the complete piece.

Tube sockets are mounted on their appropriate wafers so that the pins connect with suitable notches.

Module Assembly: Uniform wafer-mounted component parts, wafer-mounted coils, toroids, potentiometers, and crystals are assembled into a module in one machine. Here's how a typical assembly is formed: (1) Six vibrator feeders send wafers to a loading device that holds the wafers in an upright position. (2) A chain drive carries the wafer fixture to a soldering position at which six riser wires are guided into appropriate notches, three on a side. (4) A rotating mechanism turns the unit 90 deg and the chain drive carries it to another soldering position where six more wires are bonded to the module. (5) The riser wires are clipped at specified positions.

Automatic Inspection: During each stage of mechanized production there is 100 percent automatic inspection, both a physical gaging and electronic comparison. To do this, MPE uses electronic computers, bridge circuits, and other comparison devices. The testing code is contained on punched cards prepared by the design engineer (see opposite page).

FOREIGN NEWS

• MILITARY MEN have been watching political changes in Italy with more than casual interest. Their chief concern: U. S. offshore procurement orders placed in Italy total more than $384,125,000. Delays in filling these orders will further upset NATO defense schedules. U. S. purchases aimed at bolstering the Italian economy and are spread in many fields:

Aircraft	$42,521,548
Artillery and Small Arms	1,350,000
Ammunition	233,011,716
Electronics	27,391,312
Non-Combat Vehicles	9,599,777
Ships	**68,038,280**
Miscellaneous Supplies	1,285,600

• MEETING PRODUCTION GOALS is not as easy as setting them. Pravda, official Soviet News Agency, recently admitted that Russian engineers had achieved only spotty success in boosting labor productivity and cutting production costs. The news agency blamed production workers for excessive rejects and failure to use tools properly.

• AT THE TRIESTE FAIR, one of the biggest attention getters was the Ionoscintilla, an automotive accessory that supposedly ionizes compressed intake gases to assure more complete combustion of the gasoline-air mixture. The result, according to the manufacturer, is a reduction in fuel consumption of ten to fifteen percent with no loss in output. The gadget is fitted in parallel in the high voltage portion of the ignition circuit, transforming it from a low to a high frequency one.

• THERE'S MORE PROOF that Germany has recovered from the effects of World War II and is determined to corner a larger share of world markets. German firms led by Friedrich Krupp and Company and Demag (Deutsche Eisen Metall A.G.) will build and help finance a new $150 million dollar steel mill for India. The plant will be the third of its kind in the far eastern country. It will boost Indian steel production by one-third—producing 500,000 tons anually at first and eventually will turn out a million tons.

HOW TO CHOOSE A

SMALL LIGHT RELAY...

from the Automatic Electric line

When there's one *best* miniature relay for a given job, be sure you get it! Select the proper Automatic Electric relay and get peak performance, lower costs.

Painstaking workmanship, rigid quality controls and advanced design features have produced a wide range of performance...fast...sensitive...rugged...with a dependability that meets the stresses and strains of the world's toughest applications. The great demand for these relays makes careful planning worth your while to assure required delivery of the particular relays you need!

Complete facts and figures on Automatic Electric's Relay line are yours upon request—ask for Circular 1702. Write Automatic Electric Sales Corporation, 1033 W. Van Buren St., Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

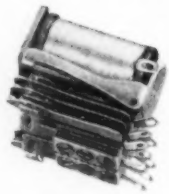
RELAYS **SWITCHES**

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

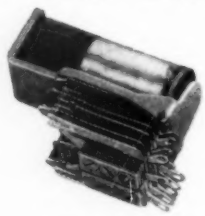
AUTOMATIC ELECTRIC

CHICAGO

WHEN SIZE AND WEIGHT ARE LIMITING FACTORS . . .
Choose this smallest of all Automatic Electric miniature relays. Capacity: 6 contact springs. Weight: 1½ oz. Dimensions: $1^{17}/_{32}$" x $1^{5}/_{16}$" x $^{11}/_{16}$". *Specify: Series SQA Relay.*



WHEN GREATER CONTACT SPRING CAPACITY IS REQUIRED . . .
Choose this double pile-up relay—larger spring capacity in miniature. Capacity: 12 contact springs (up to 18 in some cases, depending upon operating requirements). Weight: 1½-2 ozs. Dims.: $1^{17}/_{32}$" x $1^{3}/_{8}$" x 1". *Specify: Series SQD Relay.*



WHEN ADDITIONAL COIL VOLUME IS IMPORTANT . . .
Choose this relay which accommodates a slug or sleeve for longer release and/or operate time; a second winding for holding, knock down, or separate operation; or greater winding volume for increased sensitivity or greater heat dissipating ability. Capacity: 12-18 contact springs. Weight: 2-4 oz. Dimensions: $2^{1}/_{16}$" x $1^{3}/_{4}$" x 1". *Specify: Series SLQ Relay.*

FOR EXTRA SENSITIVITY
The "sensitivity" of a Class "S" Relay can be doubled through the use of oversized coils (⅛" larger diameter than standard coils). For example: under favorable conditions, standard size coils permit operation of 1 Form "C" spring combination at 4 milliamperes, 24 volts dc; similarly oversized coils permit operation at 2 milliamperes, or less.

HERMETICALLY SEALED—SPECIAL MOUNTINGS
Class "S" Relays are available with or without plug mountings. A wide variety of hermetically sealed enclosures are offered for protection of single or multiple relays.

How Fast Does a Spring Expand?

J. M. RAMRATH
Boston Works
Allis-Chalmers Mfg. Co.

IT FREQUENTLY IS NECESSARY to find instantaneous values of time, acceleration and velocity for the expansion or contraction of a spring. The following is a simple, graphical method of getting these data for both tension and compression springs. It assumes that the force requirements and spring characteristics are known and the spring rate is constant.

The first step is to draw a curve of spring displacement vs. load such as Fig. 1. The point F_o represents the position of zero force. Force F_1 is the load at the final compressed position. F_2 and F_3 represent the forces at intermediate points in the stroke.

At point F_o a perpendicular is erected. The stroke, R, then is rotated about F_o from the horizontal to this perpendicular. Lines F_2 and F_3 are extended to intersect the circle described by R; the points of intersection are connected to F_o. Thus, a displacement angle ωt is obtained for each position of the rotating vector. These angles, from which the required data can be calculated, can be measured directly. For greater accuracy, they can also be determined mathematically using the trigonometry functions in Fig. 1 with the fundamental equation

$$F = Ma \qquad \text{where (1)}$$

M is the mass of all parts accelerated by the spring plus one-third of the mass of the spring itself. Since the spring follows the laws of simple harmonic motion, the acceleration can be expressed as:

$$a = R\omega^2 \cos \omega t. \qquad (2)$$

This acceleration is a maximum at the beginning of motion, at which time the displaced angle ωt_{F1} is zero and cos ωt_{F1} is unity. Substituting the latter into Eq (2),

$$\omega = \sqrt{a/R} \text{ rad/sec.}$$

The displaced angle at the end of the stroke, ωt_{Fo} is 90 deg. Expressed in radians, it is 1.57. From this, the time elapsed for the stroke is

$$T_{Fo} = \frac{1.57}{\omega} \text{ sec.}$$

Since the angular velocity ω is constant, the above value may be substituted into Eq (2) to get instantaneous values of time. Similarly, from simple harmonic motion,

$$V = R\omega \sin \omega t. \qquad (3)$$

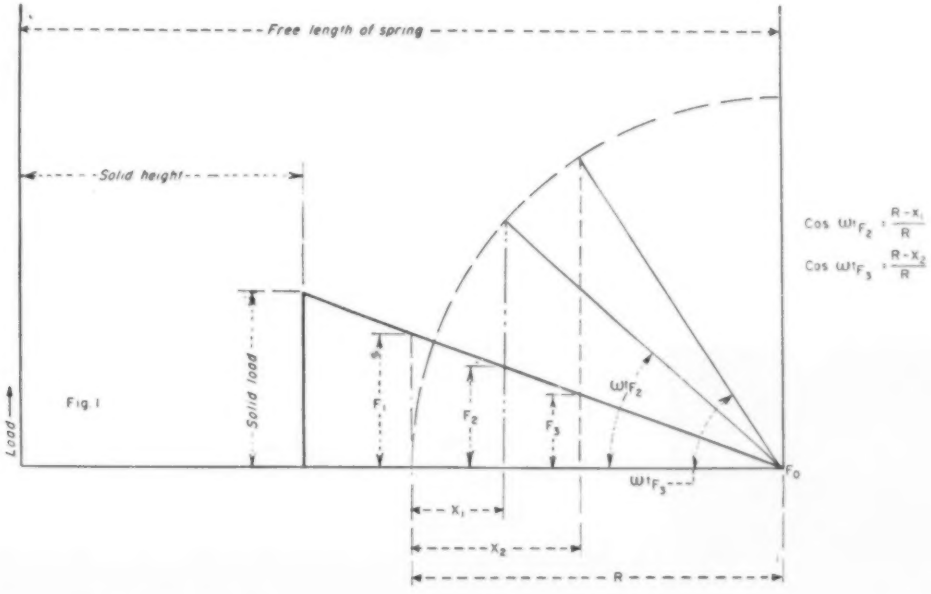
This can be used to get instantaneous velocities.

To illustrate the method, consider the example represented by Fig. 2. The spring has $2\frac{7}{8}$ in. OD, 0.3125 in. wire, dia., 8 active turns, and $9\frac{1}{2}$ total turns. The free length is $6\frac{7}{8}$ in. and the solid load 397 lbs. At compressed position it exerts a force $F_1 = 332$ lbs. After $1\frac{1}{2}$ in. of expansion, force $F_2 = 180$ lbs and after an additional $1\frac{1}{2}$ in. of expansion force $F_3 = 30$ lbs.; $\frac{5}{16}$ in. more travel carries it to its fully expanded position, F_o. Time, acceleration and velocity are to be found for the various positions of the spring.

Weight of accelerated parts = 6 lbs.;

$$M = \frac{6}{32.2} = 0.1863 \text{ slugs}$$

(continued on page 211)



NEW PLASTIC MATERIALS ADD PROPERTIES NATURE FORGOT

Look to today's new materials for help in putting new properties into your product

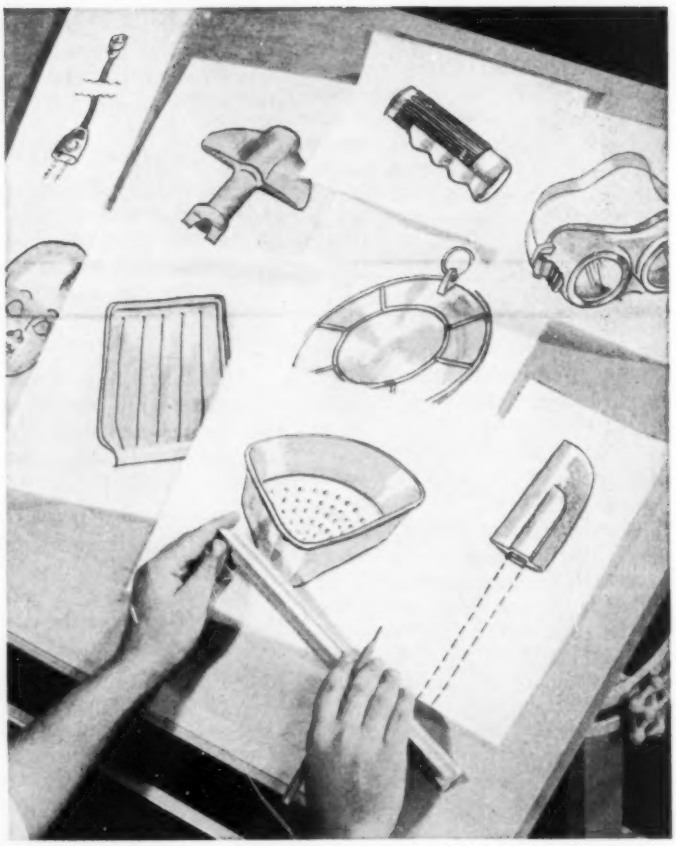
What properties would you like to add to your product? Flexibility . . . toughness . . . chemical resistance . . . smarter appearance . . . color?

For many manufacturers (and you may be one), better, faster selling, more versatile products will be a reality tomorrow . . . because of new, improved materials uncovered by Monsanto research today.

For example: Monsanto recently developed a new technique for molding its Opalon vinyl resin . . . which greatly widens the range of applications for injection molding vinyl chloride. Typical of the vast research daily devoted to plastic materials, processes and applications, this latest development in the injection molding of Opalon dry blend vinyl resin opens new design opportunities for manufacturers of electrical equipment, flexible fittings, appliances, sporting goods, housewares, toys and many industrial products.

Perhaps you, too, have a use for Opalon—or another Monsanto plastic—in your present products, or ones still on the drawing board calling for properties possible with one of the new plastics. You'll find answers to many of your questions about these new materials in Monsanto's latest report to management. Send for your *free* copy today; the coupon is for your convenience.

Opalon: Reg. U. S. Pat. Off.



For products such as automotive and refrigeration parts, sporting goods, toys, housewares, etc., Monsanto's Opalon vinyl plastic delivers flexibility ranging from soft to semi-rigid . . . outstanding electrical properties . . . resistance to abrasion, moisture, oxidation, most acids, alkalies and common solvents . . . and a wide range of color.

FREE—REPORT TO MANAGEMENT

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2134
Springfield 2, Mass.

Please send me your new management report on new materials aiding design.

Name & Title _____

Company _____

Address _____

City, Zone, State _____

MONSANTO

SERVING INDUSTRY . . . WHICH SERVES MANKIND

How Fast Does a Spring Expand? (continued)

Weight of spring =

$$1.67 \text{ lb.}; M_{sp} = \frac{1.67}{32.2 \times 3} = 0.0173 \text{ slugs}$$

Thus,

$$M_{total} = 0.2038 \text{ slugs}$$

Initial acceleration,

$$a_{F1} = \frac{F_1}{M_{total}} = \frac{332}{0.2038} = 1{,}630 \text{ ft/sec}^2$$

Rotating vector,

$$R = 3\frac{5}{16} \text{ in.} = 0.276 \text{ ft}$$

Angular velocity,

$$\omega = \sqrt{\frac{a}{R}} = \sqrt{\frac{1630}{0.276}} = \sqrt{5{,}900} = 76.8 \text{ rad/sec}$$

From Fig. 2,

$$\cos \omega t_{F1} = 1$$

$$\cos \omega t_{F2} = \frac{R - X_1}{R} = \frac{3\frac{5}{16} - 1\frac{1}{2}}{3\frac{5}{16}} = 0.5471$$

$$\cos \omega t_{F3} = \frac{R - X_2}{R} = \frac{3\frac{5}{16} - 3}{3\frac{5}{16}} = 0.0944$$

$$\cos \omega t_{F0} = 0$$

Therefore,

$\omega t_{F1} = 0$
$\omega t_{F2} = 56 \text{ deg } 50 \text{ min} = 0.99 \text{ rad}$
$\omega t_{F3} = 84 \text{ deg } 35 \text{ min} = 1.48 \text{ rad}$
$\omega t_{F0} = 90 \text{ deg} = 1.57 \text{ rad}$

Substituting in Eq (2),

$a_{F1} = 1{,}630 \text{ ft/sec}^2$
$a_{F2} = 0.276 \times 5{,}900 \times 0.5471 = 890 \text{ ft./sec}^2$
$a_{F3} = 0.276 \times 5{,}900 \times 0.0944 = 153.5 \text{ ft/sec}^2$
$a_{F0} = 0 \text{ ft/sec}^2$

And, dividing the ωt values by ω,

$t_{F1} = 0 \text{ sec}$

$$t_{F2} = \frac{0.99}{76.8} = 0.0129 \text{ sec}$$

$$t_{F3} = \frac{1.48}{76.8} = 0.0193 \text{ sec}$$

$$t_{F0} = \frac{1.57}{76.8} = 0.0204 \text{ sec}$$

Using Eq (3) and the following values for the trigonometry functions,

$\sin 0 = 0$
$\sin 56 \text{ deg } 50 \text{ min} = 0.8371$
$\sin 84 \text{ deg } 35 \text{ min} = 0.9955$
$\sin 90 \text{ deg} = 1.0000$

$V_{F1} = 0$
$V_{F2} = 0.276 \times 76.8 \times 0.8371 = 17.7 \text{ ft/sec}$
$V_{F3} = 0.276 \times 76.8 \times 0.9955 = 21.1 \text{ ft/sec}$
$V_{F0} = 0.276 \times 76.8 \times 1 = 21.2 \text{ ft/sec}$

To obtain all instantaneous values, rotating vector diagram, Fig. 3, is constructed. A convenient time scale is found and laid off on the horizontal line. Then, R is laid off to any convenient scale. The curve points produced from $X_1 t_{F2}$, $X_2 t_{F3}$ and $R\, t_{F0}$ are connected with a smooth sine curve. This constitutes the displacement curve ωt. In the end point of the time scale a perpendicular line is erected and the velocity points marked off on it to a convenient scale.

Similarly, the velocity curve points are connected. The acceleration curve is drawn by erecting a perpendicular line at the zero time point and using a sine curve to connect all points.

It is now possible to determine at a glance at what time interval a certain point is reached in the displacement curve and what the velocity and acceleration are for any such point.

It may readily be seen how this method can find many applications in a variety of problems. If the parts have angular rather than linear acceleration the radius of gyration of the moving mass, the mass moment of inertia, the torque and angular acceleration must be found first to establish a_0. Once a_0 is found, the problem can be treated in the described manner.

(continued on page 213)

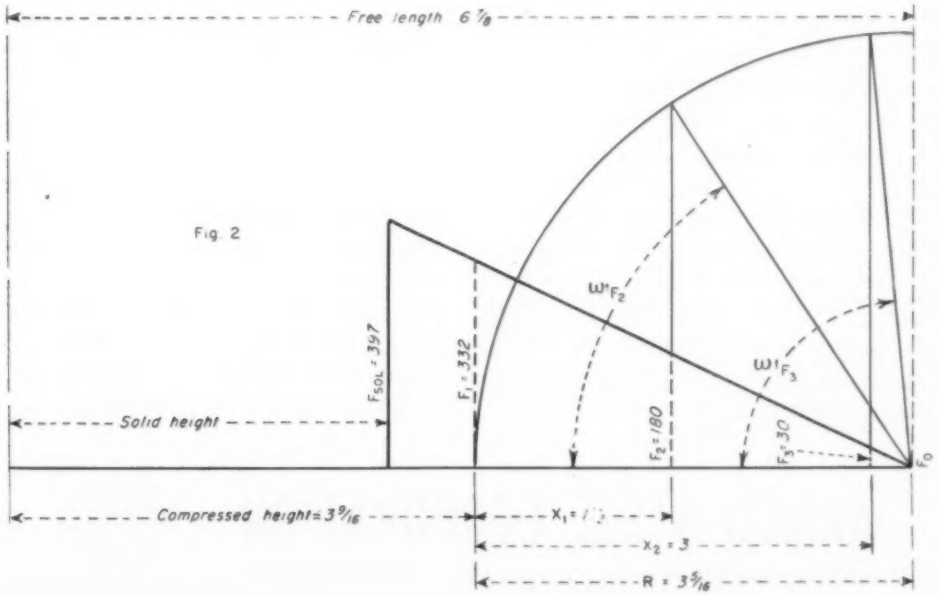
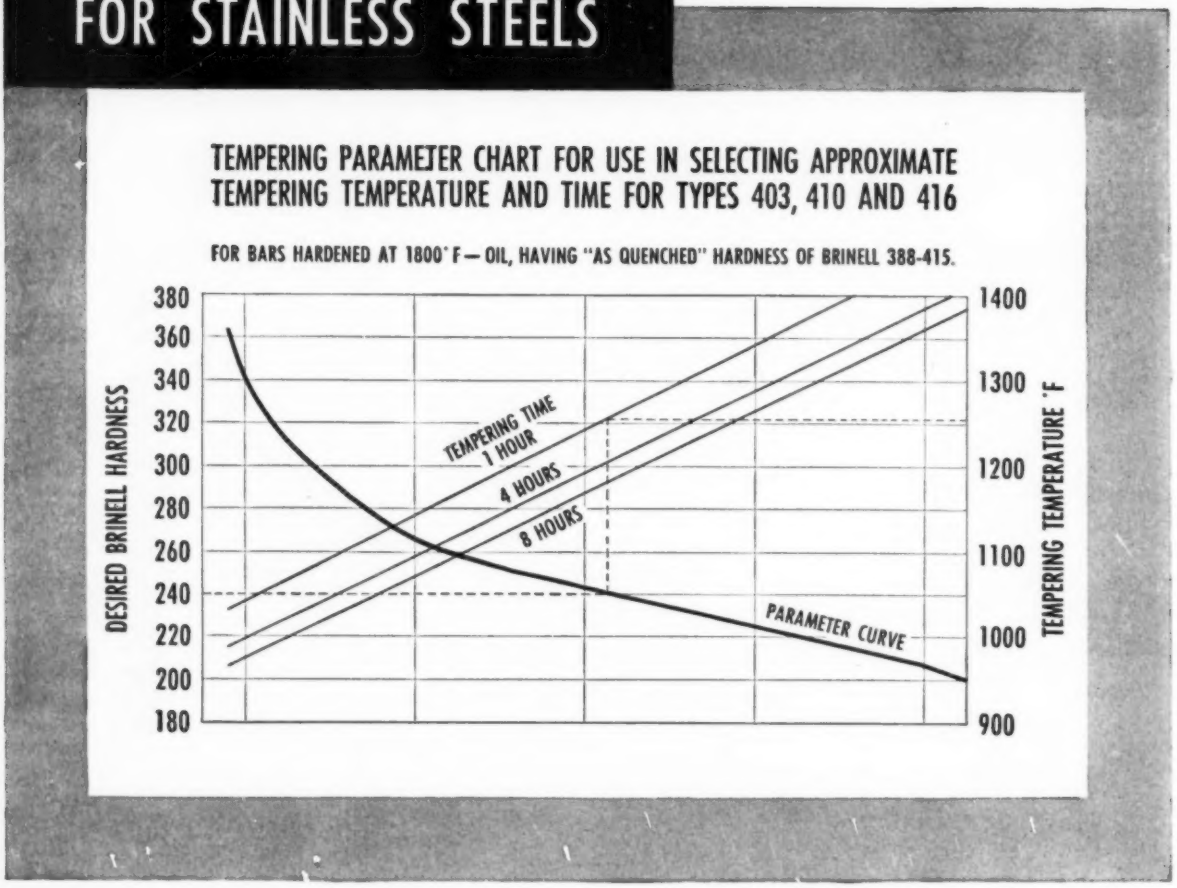


Fig. 2

NEW TEMPERING CHART FOR STAINLESS STEELS



Here's a handy chart for the tempering of Types 403, 410 and 416 stainless steels. It combines hardness, time and temperature. For a specified tempered hardness and desired tempering time, it will serve as a guide in finding the required temperature.

This is the way the chart works. For example, if you want a tempered hardness of Brinell 240 in 1 hour tempering time, first find 240 on the hardness scale at the left. Where that hardness level intersects the parameter curve, draw a vertical line through the sloping 1 hour tempering-time line. A horizontal line from this intersection to the temperature scale at right shows approximately 1250 degrees F. The corresponding temperature for 4 hour tempering time is 1200 degrees F, for 8 hours 1180 degrees F.

This is one example of the work of Armco's metallurgists to help you gain full advantage of the excellent corrosion resistance and mechanical properties of the stainless steels.

CALL ON ARMCO'S METALLURGISTS

The assistance of Armco's metallurgists is available to you. It will pay you to call on them to work with you. And write for a copy of our new handbook, "Heat Treating, Forging and Pickling of Armco Stainless Steels."

Armco Stainless Steels are produced in all standard and many special types in sheets, strip, plates, bars and wire.

ARMCO STEEL CORPORATION

4643 Curtis Street, Middletown, Ohio • Export: The Armco International Corporation

ARMCO

How Fast Does a Spring Expand? (continued)

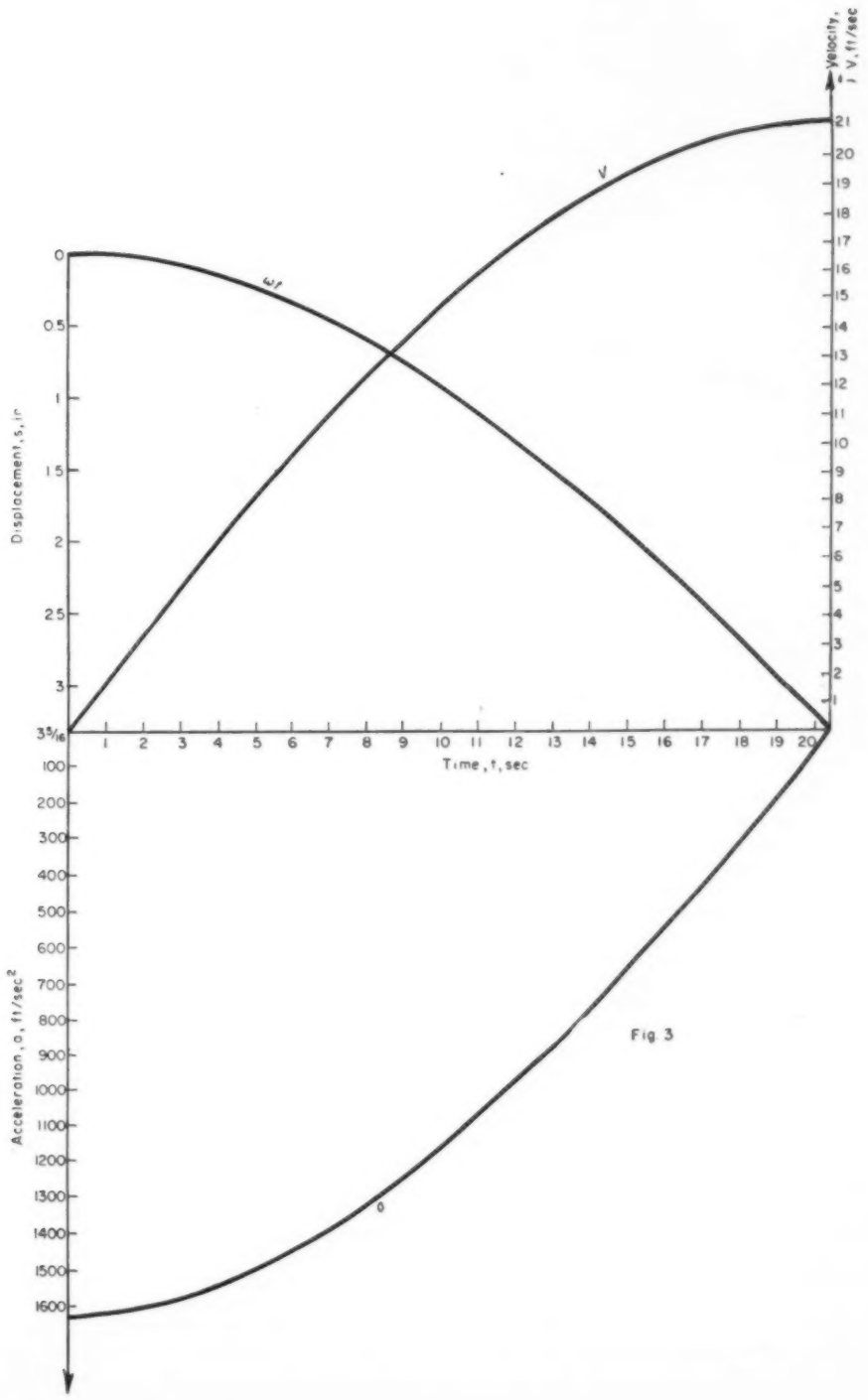
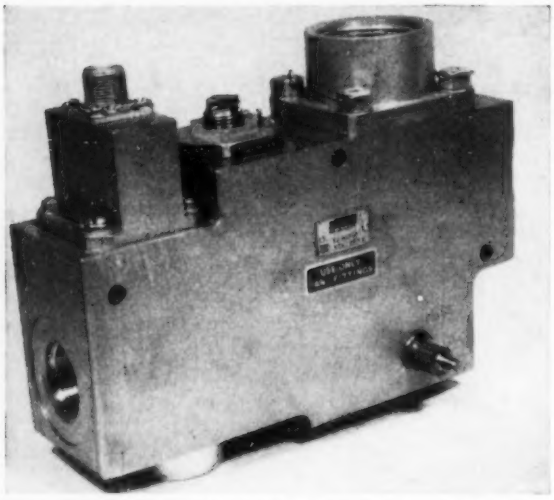
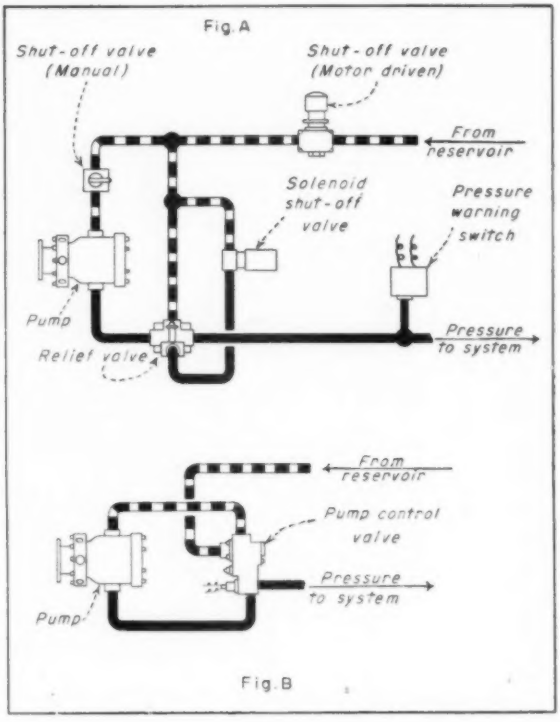


Fig. 3



WHEN USED ON LATE MODEL PASSENGER PLANES, four of these valves—one per pump—will be used. This allows a reduction in the number of separate hydraulic units from 14 to 4, and eliminates four electrical switches. The installation weight saving here is also of value.

As an example of how this valve reduces parts, the circuit diagram, Fig. B at right, provides all the services performed in the circuit above, which does not have the valve.



Compact Pump Control Valve Replaces

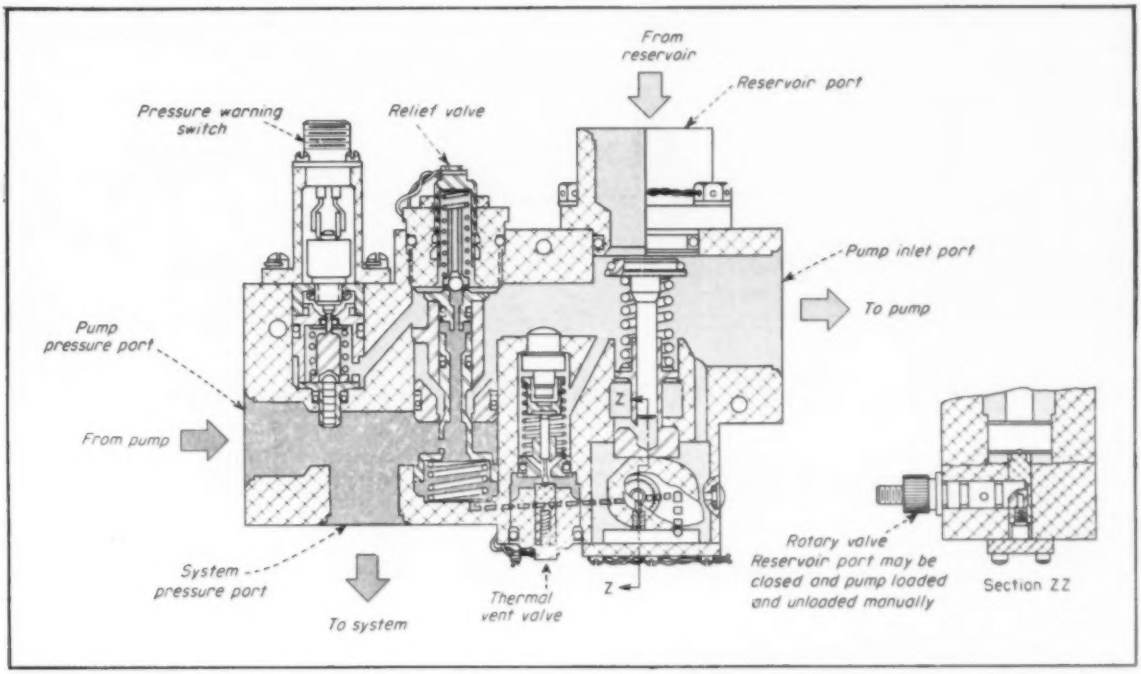
Designed to reduce the number of accessories used in a hydraulic system, this pump control valve is used in systems where a number of controlled functions, normally requiring several accessories, can be handled by one unit. This one unit is used where it is desirable to automatically unload pump delivery at a low pressure into the suction side when the oil temperature has reached a predetermined maximum. The design includes: manual unloading of the pump; a pressure actuated electric switch for use in a signal system to indicate system pressure changes; and a built-in relief valve to limit the system pressure. The pump shut-off manual control also serves as a firewall shut-off device.

Late model passenger planes will be equipped with four of these valves—one per pump. Use of this accessory is said to permit a reduction in the number of separate hydraulic units from fourteen to four, and at the same time eliminating four electrical switches. Replacement of the multiple accessories by the single valve is also said to reduce the inventory and spare parts demands by about two-thirds. This does not include the savings caused by the simplified plumbing.

The heart of the valve, consisting of the working parts from a conventional —8 size relief valve made by this company, which when open, provides a passage between the pressure side and the return side of the hydraulic system. During normal operation, the valve remains closed, and hydraulic fluid is allowed to move at system pressure from the pump to the hydraulic system. Oil at system pressure passes through a small drilled hole in the spool and into the relief valve bottom chamber. The spool and the ball seat have a central bore which allows oil under pressure to be ported to the under side of the control ball.

As soon as excessive pressure is built up in the central bore, the ball is forced off its seal allowing fluid to escape to the low pressure side of the valve. The unbalanced pressure at the base of the spool allows the spool to be forced down off its seat against spring action, and allows excessive pressure to be released up through the angular drilled passages to the return line. As the system pressure is reduced, the ball and spool return to their respective seats and normal system pressure is again built up.

A manually-operated rotary valve, which is an integral part of the pump control valve, provides a manual shut-off to isolate the pump or to act as a firewall shut-off to keep inflammable fluids from the engine fire zone. As the operating shaft is turned, a cam lifts a valve to seat against the port from the hydraulic system reservoir. Because this operation would cause cavitation, a passage is made in the shut-off valve actuating shaft. This passage relieves



CALLED A 5 IN 1 HYDRAULIC ACCESSORY, this 18 gpm pump control valve is used where it is necessary to automatically unload pump delivery at a low pressure into the suction side when the oil temperature has reached a predetermined maximum.

Hydraulic System Accessories

hydraulic pressure on the underside of the relief valve spool, causing is to open and send pump discharge back to the inlet side of the pump.

The thermal vent valve contains an element which is sensitive to temperature changes. It is immersed in the hydraulic oil, and as temperature rises the element expands, pressing down on a poppet valve which unseats to vent the relief valve. The relief valve then opens, causing the affected pump circuit to isolate itself from the main hydraulic system. As the temperature of the oil is reduced, the thermal sensing element contracts, the relief valve vent passage closes, the relief valve returns to normal position, and oil under pressure is again provided for the circuit to allow normal operation.

The pressure warning switch used in this valve is a simple on-off device which closes an electrical circuit when the pump output pressure falls below a predetermined figure.

The maximum capacity of the valve, called the model AA-40510 is 18 gpm. The relief valve setting for cracking pressure is 1,800 psi, min; for full flow pressure, 2,050 psi, max; re-seat pressure, 1,750 psi, minimum. The pressure warning switch is on at 1,325 psi, ±50 psi; and off at 1,450 psi, ±50 psi. The thermal vent valve unloads at 178 to 190 F, and loads at 160 to 172 F.

Torque required for manual operation at 30 psi inlet oil pressure: unload, 15 lb-in.; load, 16 lb-in.; shear, 155 lb-inches. The pressure drop from the reservoir connection to the pump suction connection at 18 gpm is 4 psi, maximum, and the pressure drop from the pump pressure connection to the system pressure connection at 18 gpm is 10 psi maximum.

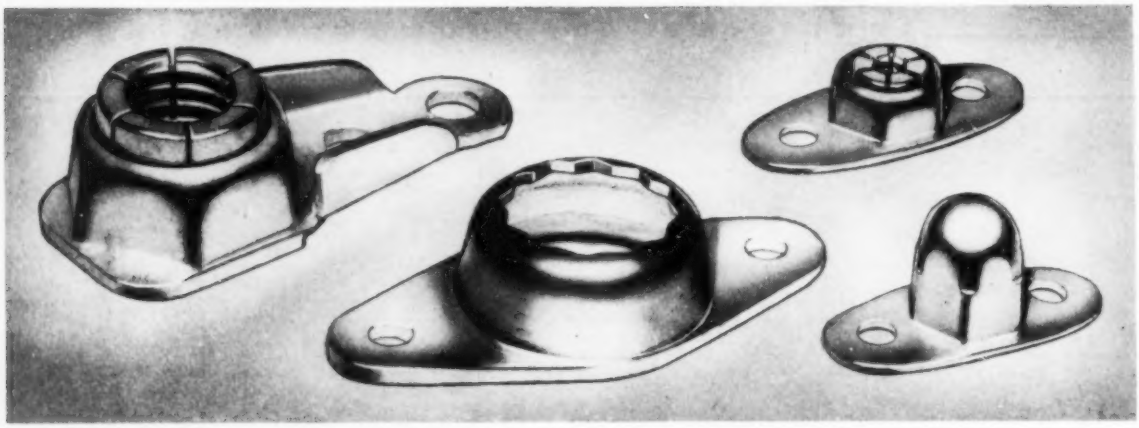
When used on aircraft, this valve permits unlimited operation of the hydraulic pumps in the shut-off position without damage. Therefore, individual pump performance can be checked with all the engines running, without the possibility of damaging the other three when shut off. In addition, the suction hose will not collapse when the pump is shut off.

And, if some malfunction in the system causes an excessive fluid temperature rise, the thermal feature will automatically cut out the pump involved.

A typical circuit installed in one of today's transport type aircraft is shown below as illustration A. Illustration B shows the circuit configuration for the same aircraft using the pump control valve. All original services are still provided but the number of accessories has been reduced and the plumbing simplified.

Vickers, Inc., 1400 *Oakman Blvd., Detroit* 32, *Mich.*

CONTINUED ON PAGE 216



Strong, Light Weight, Self-Locking Nuts

Increased strength and narrow AN envelope dimensions on width are the improvements of a self-locking, light weight one lug anchor nut made in both $\frac{1}{4}$-28 and $\frac{5}{16}$-24 thread sizes. Shown above, left, this retainer is made of cadmium plated SAE 1050 heat treated steel and meets the requirements of specifications AN-N-5 and AN-N-10.

Retainers for external wrenching nuts, center, make a high strength anchor nut out of the standard external wrenching nut. Standard anchor nut rivet hole spacing has been adopted to permit interchangeability. It is available for external wrenching nuts with thread sizes from $\frac{1}{4}$-28 through 1-14. The retainer is made of cadmium plated steel and has a fastener combination capable of resisting 160,000 psi tensile stress.

The two self-locking anchor nuts shown at right have small envelope dimensions and light weight, and are made in 4-40 and 6-32 thread sizes. The nuts are alike in design, except for the addition of a dome on one. This was designed to prevent wire chafing on screw threads in electrical assemblies where leads may run close to the nut.

Nutt-Shel Co., Inc., 811 *Airway, Glendale* 1, *Calif.*

Right-Angle Speed Reducer Mounted in Any Position

Designed to convert a high motor speed into a low speed, high torque output, this right-angle Motoreducer permits the simultaneous use of as many as 3 output shafts from the same motor, when desired. (One high-speed take-off directly from the motor shaft, and either 1 or 2 low-speed take-offs from the reducer). The drive motor can be either standard squirrel cage, slip ring, multi-speed or fluid-shaft, in either drip proof, splash proof or totally enclosed designs. Other features are greater versatility in mounting and load hook-up, plus short overall length and all-position operation (floor, ceiling, side or wall mounting).

All units are also available with through-shaft, automatic magnetic brakes as an integral part. When used with fluid-shaft motors, the brake can be located on either, or both, the input and output sides of the fluid coupling.

The right-angle motoreducers are available in $\frac{1}{2}$, $\frac{3}{4}$, 1 and $1\frac{1}{2}$ hp ratings with speed reductions to as low as 18, 24, 36 and 58 rpm respectively. Foot or ring mounting is optional. The illustration shows a 1 hp fluid shaft right-angle unit.

Another model of the Motoreducer is available with: a magnetic brake; a motor with an internal fluid coupling; a second magnetic brake; and a gear reducer. This unit is able to give fluid-cushioned stops and starts, with the added advantage of a holding brake.

Reuland Electric Co., Alhambra, Calif.

CONTINUED ON PAGE 218

Extra

dependability through extra value features...in Adlake Mercury Relays

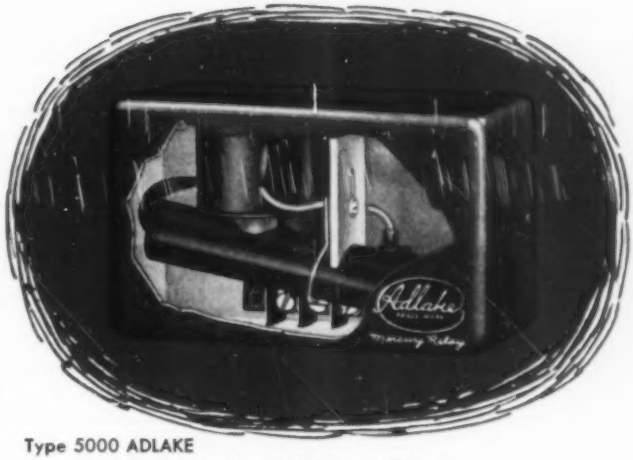
Dependability is the sum of many things . . . and ADLAKE's dependability is built on a combination of plus features like these:

Positive leak-proof sealing—assured by the use of properly selected metals and glass components with properly matched thermal expansion characteristics.

Arc-resisting ceramics—ceramics with great temperature-resistance are used to reduce any destructive effect caused by the arc.

Liquid mercury-to-mercury contacts—completely eliminate failures caused by low contact pressure, contact burning, pitting and sticking . . . and the inherent high surface tension of mercury imparts an ideal snap action to contacts.

What's more, every ADLAKE Relay is absolutely safe . . . silent and chatterless . . . and requires no maintenance whatsoever. Get the complete story today . . . write for your free copy of the ADLAKE Relay Catalog. The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana; in Canada, write Powerlite Devices, Ltd., of Toronto.



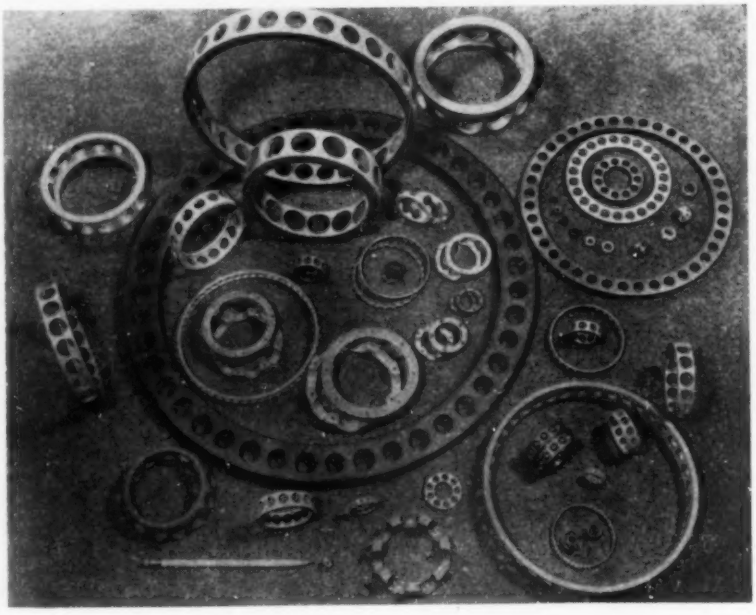
Type 5000 ADLAKE
Sensitive Relay Contact Normally Open or Closed

Adlake 96th year

THE
Adams & Westlake
COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Higher Speeds With Plastic Ball Bearing Retainers



Laminated plastic ball bearing retaining rings, fabricated in a variety of styles, are now being used on machine tools, grinding spindles, supercharger blowers, and in some applications where speeds are in excess of 100,000 rpm. The light-weight material with easy machinability makes possible the tolerance required for precision bearings.

Due to the smaller masses involved, centrifugal forces resulting from high speeds are reduced, starting torques are lower, the overall bearing weight is reduced, and galling is eliminated. The laminates, while almost impervious to oils and greases, do absorb a small amount of lubricant in the fibers during machining, giving them self-lubricating characteristics.

The retainers are fabricated in: single row, deep groove; single row, low angle contact; single row, high angle contact; and double row, self-aligning styles. Retainers range from $\frac{1}{4}$ to 33 in. O. D., with the smallest retainer produced being 0.100 in. I.D., 0.143 in. O. D. and 0.088 in. long with six, $\frac{3}{64}$ in. ball pockets. This small retainer was designed for use in aircraft instruments.

Laminated retainers may be fabricated from either tubing or sheet stock, depending on the type of bearing involved. Tubing is generally used for one piece radial bearing retainers. Sheet stock is used for thrust bearing retainers, and for smaller two piece retainers whose thin walls might be cracked by riveting operations. Drilling holes perpendicular to the laminations preserves the maximum mechanical strength of the plastic.

Three major types of ball pockets are drilled: 1—the snap-in pocket; 2—the Cherry reamed pocket; and 3—the straight-through pocket.

The snap-in pocket is designed so that the ball must be snapped or forced into the pocket. The diameter of the pocket is largest where the ball spins. The hole at the surface from which the ball is inserted is large enough to permit the ball to pass through when forced, but too small to permit it to fall through accidentally. Snap-in pockets can be used in either radial or thrust-type bearing retainers.

The Cherry-reamed pockets consist of a straight hole with a retaining shoulder at one end to prevent the ball from passing through. Once loaded, the retainer must be assembled to a bearing race to keep the balls from rolling out the open end during handling.

Cherry-reamed pockets must be held to close tolerances when designed for ball-bearing retainers. In land-riding retainers, the tolerances are not as critical. Manufacturing dimensions are held down to +0.001 in.

Synthane Corp., Oaks, Pa.

Air And Hydraulic Pilot Valves

Four-way valves for operation of pneumatic and light hydraulic cylinders, are of the D-slide type, with the port-exchanger slide being operated by a double acting cylinder in one series and by a spring return cylinder in another series.

The nylon port exchanger was service tested to 50,000,000 cycles and found to be undamaged, as was the pilot cylinder assembly which is of hard surfaced aluminum. Valves can be operated without lubrication where oilless operation is required. Valves can operate on pressures from 3 to 200 pounds.

All of the valves can be operated manually or electrically by interchanging the operating valve units. The manual operating valves can be used for push button starting, or as air limit switches for automatic return of cylinder piston.

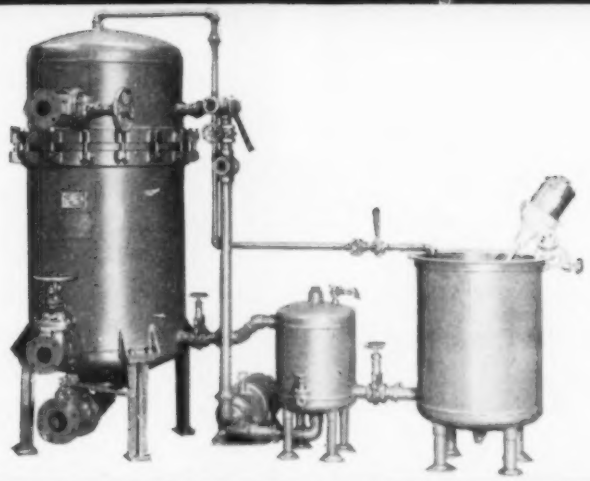
The valves are $2\frac{1}{2}$ x $2\frac{1}{2}$ x 2 in. in size although capable of delivering media from full $\frac{1}{4}$ and $\frac{3}{8}$ in. orifices. The valves are ported with cylinder port at 90 deg so that valves can be mounted directly to rear or side ports of cylinders.

Also offered for use with these valves are: operating valves; speed controls; and reuseable fittings.

Airelectric Corp.,
P. O. Box 208, Melrose Park, Ill.

CONTINUED ON PAGE 220

HOW TO FILTER SWIMMING POOL WATER



another successful product design with piping equipment by CRANE

Keeping swimming pool operators happy—and swimmers healthy—is big business with R. P. Adams Co., Inc., of Buffalo, N. Y. For theirs is an outstanding and popular line of water filters such as type WFF shown above.

In keeping with sound basic design, Adams' engineers choose equipment of utmost dependability and low-cost maintenance. In piping materials, for example, they prefer Crane because of the traditional better quality and thrifty performance of Crane valves and fittings.

Most design engineers know they need but turn to their Crane catalog to make piping specifications come easier. It's their best guide to the biggest selection of valves and fittings for all applications . . . their best source of complete specification data . . . sizes and dimensions, temperature and pressure ratings, materials and construction. And more important, the Crane name on piping equipment puts an added mark of quality and value on product design.

Crane Wedge Disc Clamp Gate Valve . . . extra strong, extremely compact. Clamp design is ideal where frequent cleanout is essential. Bonnet assembly and disc lift out—body stays in the line. O. S. & Y., inside screw, and quick-opening patterns, all-iron or brass trimmed. Screwed or Flanged ends. Sizes up to 4 in. Working pressures up to 150 p.s.i. saturated steam, 225 p.s.i. cold service.

YOU'LL FIND IT HERE ...IN YOUR CRANE CATALOG

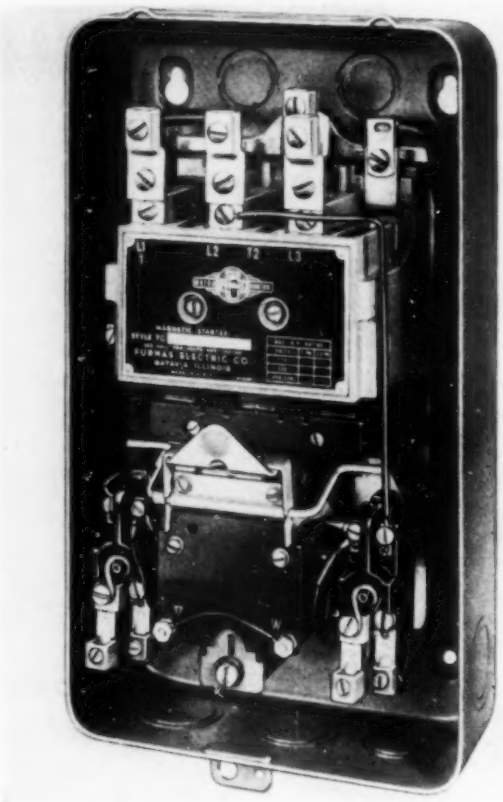
THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

In-Between Size Magnetic Starter



Having a slightly greater capacity than a size 2, and less than size 3, a new size starter and contactor known as the series YG does not fall into the conventional pattern of sizes and is referred to as size 2½. The polyphase rating is 20 hp at 208-220 v a-c, and 30 hp at 440-550 v a-c; Single phase rating: 5 hp at 110 v, 10 hp at 208-220 v a-c. The starters are available with a built-in push button or selector switch.

The series YG includes starters, reversing starters, contactors and reversing contactors as open type, in general purpose steel cases and in water-tight, dust-tight housings. An additional single-pole, double-throw switch can be added by the user if required for interlocking.

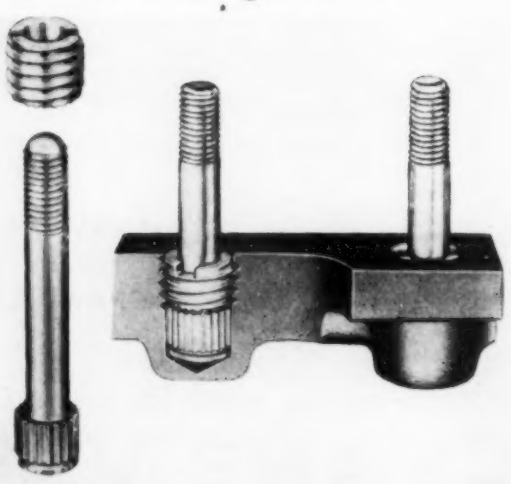
Since this series has horsepower capacities overlapping the conventional size 2, in many cases it is not necessary to use a size 3 starter. The same applies to the physical size, since the series YG is smaller than size 3.

The series YG (size 2½) starters and contactors differ from YF (size 2) series in that the YG series are of heavier construction, use 27 percent larger contact parts, and have larger terminals, resulting in higher ratings; the overall enclosure size is the same as the series YF.

Neither motor nor line wires have to be removed to replace the contacts; the coils can be changed by removing the coil leads and only one screw. Water-tight and dust-tight cases are of cast aluminum alloy.

Furnas Electric Co., Batavia, Ill.

Threaded Stud Has Special Locking Insert



This threaded stud, which may be installed in metal or plastics, differs from the conventional double threaded stud in that it has a knurled head and is fitted with a pressure ring. This acts as a positive lock against rotation and pull-out. The knurled head broaches its way into the base material and holds the stud against rotation, and the pressure ring, screwed in place, locks the stud against being pulled out.

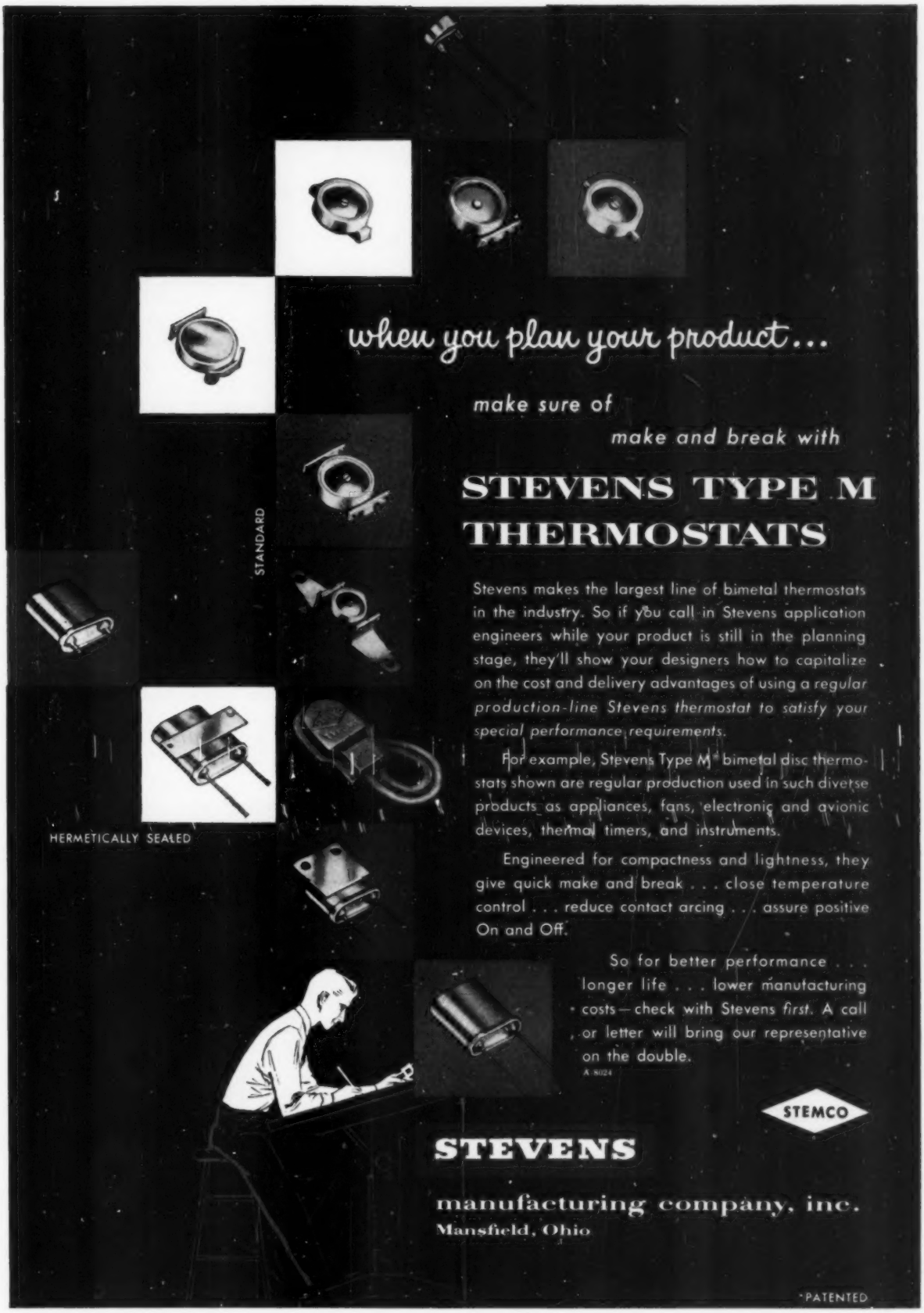
Installation or removal is easy. In the event of damage to the stud thread, the pressure ring can be unscrewed, and the stud pulled out and replaced with another stud. An advantage here is that the same pressure ring can be used over again.

The threaded studs are available in cadmium plated alloy steels with ultimate tensile strengths as high as 165,000 psi, stainless steel, or special alloys to meet various requirements.

The illustration at the left shows the stud as it is constructed in two pieces—a threaded stud with a knurled head and the separate pressure ring. The center view shows a cutaway of the stud in position, and the right hand photo shows the stud completely installed. For more information on this line of inserts, write to the manufacturer.

Newton Insert Co., 1321 *E. 17th St., Los Angeles* 21, *Calif.*

CONTINUED ON PAGE 222



when you plan your product...

make sure of
make and break with

STEVENS TYPE M THERMOSTATS

Stevens makes the largest line of bimetal thermostats in the industry. So if you call in Stevens application engineers while your product is still in the planning stage, they'll show your designers how to capitalize on the cost and delivery advantages of using a *regular production-line Stevens thermostat to satisfy your special performance requirements.*

For example, Stevens Type M* bimetal disc thermostats shown are regular production used in such diverse products as appliances, fans, electronic and avionic devices, thermal timers, and instruments.

Engineered for compactness and lightness, they give quick make and break . . . close temperature control . . . reduce contact arcing . . . assure positive On and Off.

So for better performance . . . longer life . . . lower manufacturing costs—check with Stevens *first.* A call or letter will bring our representative on the double.

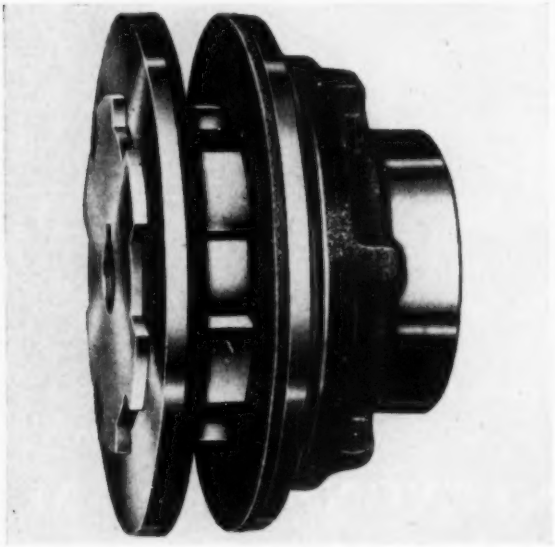
A-5024

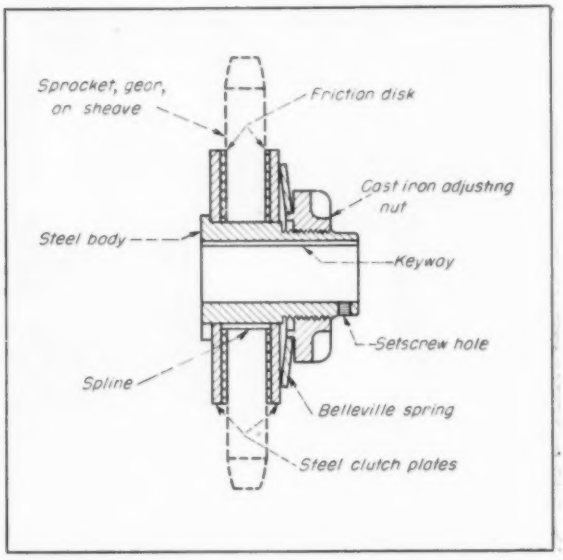
STEMCO

STEVENS

manufacturing company, inc.
Mansfield, Ohio

*PATENTED





Torque-Limiting Clutches Give Overload Protection

Adjustable torque-limiting clutches that provide overload protection for machine drives in a variety of equipment are particularly adapted to roller chain drives, and are designed to be used in connection with standard type A plain plate roller chain sprockets made by this company. These compact slip-type friction clutches act as automatic shear pin mechanisms and avoid the time required to insert new shear pins. Other types of rotating members, such as gears, pulleys, and sheaves can also be used with the new clutches.

The clutches consist of a steel body, two steel clutch plates, two friction disks, a Belleville clutch spring, and a cast iron adjusting nut. The rotating member is held between the friction disks through spring pressure exerted on the clutch plates that slide on splines on the hub. The torque setting of the clutch is obtained by adjusting the spring tension with the threaded thumb nut.

In operation, the rotating member on clutches breaks away from the disks at the overload torque setting. Then, the rotating member remains stationary in relation to the clutch hub with the friction torque of the clutch remaining at from $\frac{1}{3}$ to $\frac{1}{2}$ the overload setting. Therefore, the clutch rotating member will not operate until the drive is shut off and the overload condition corrected. The clutches are made in $4\frac{1}{2}$, $5\frac{1}{2}$, and $6\frac{1}{2}$ in. dia sizes with ratings of 55, 121.5 and 260 ft-lb respectively. Maximum bores (with standard keyways) are 1, $1\frac{1}{2}$ and $2\frac{1}{2}$ inches. Overall lengths are $2\frac{9}{16}$, 3, and $3\frac{7}{8}$ inches. Hub OD's are 2.000, 2.625 and 4.250 inches.

The $4\frac{1}{2}$ in. clutch will accommodate standard $\frac{1}{2}$, $\frac{5}{8}$ and $\frac{3}{4}$ in. pitch type A roller chain sprockets. The $5\frac{1}{2}$ in. clutch will handle these sprockets as well as 1 in. pitch sprockets. The $6\frac{1}{2}$ in. clutch will take $\frac{1}{2}$, $\frac{5}{8}$, and $1\frac{1}{4}$ in. pitch sprockets.

These torque-limiting clutches may be used as overload protection devices in the power drives of many types of industrial machinery including conveyors, materials handling equipment and devices, agricultural equipment, packaging machinery and other related types of equipment where the torque capacity of the drive does not exceed 260 foot-pounds.

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Flame-Spray Application of Porcelain on Steel

By adapting a hand-gun normally used for spraying other molten materials, a new process has been developed which shoots porcelain material through an acetylene torch and fuses it to steel. The materials necessary for the flame-spray operation are channeled to the gun by four rubber feed lines, each of which is regulated by a knob at the handle. A fifth line of compressed circulating air acts as a return feed to force the porcelain material up through the gun in a continuous stream, and also serves to maintain a cool temperature throughout the metal parts of the gun.

In the first stage of application, the flame preheats the steel surface. When the desired temperature is reached, the porcelain mixture is blown through tiny holes circling the nozzle. As this material passes through the flame, it melts at approximately 1,600 F, and is fused to the metal plate.

Seaporcel Metals, Inc., 28-20 Borden Ave., Long Island City 1, N. Y.

CONTINUED ON PAGE 224

IRVINGTON
INSULATING VARNISH DIGEST

Multiple Varnish Coats Employed on Coil Windings

The application of a series of coats of insulating varnish is a procedure that has proved exceptionally effective for the maximum protection of electrical windings which involve large spaces between coils and cores or conditions which demand greater surface protection.

The internal curing types of varnish produced by Irvington Varnish & Insulator Company are particularly suitable for the impregnation of windings where multiple coatings are required. These varnishes permit repeated dips of the coils at short time intervals. The desired build-up of the varnish coating can be obtained with only short intermediate partial baking cures. After the build-up, a single final baking cure is all that is needed to assure finished coils with high dielectric and mechanical strength.

Repeated dips of coils into internal drying varnishes permit easy build-up of desired insulating coating

Oxidizing types of varnishes can also be used for multiple coating. Thinner coats are necessary, and each coat must be thoroughly baked to assure maximum curing.

Vacuum-Pressure Varnish Application Penetrates Windings More Completely

Method Extracts Air from Pores, Capillary Vessels; Results in Better Insulation of Electrical Windings

While satisfactory results in the impregnation of electrical windings by insulating varnishes can frequently be obtained with the relatively simple equipment used for dipping procedures, more effective penetration results from the use of the vacuum-and-pressure method. In this type of application, air is first evacuated from the impregnating tank. Varnish is then pumped from a storage tank into the impregnating tank, and pressure is applied.

Internal curing varnishes, which cure throughout by polymerization, are particularly well adapted to make most effective use of the thorough penetration resulting from the vacuum-pressure method.

Equipment of this type, designed for application of vacuum and pressure within the impregnating tank, assures more effective penetration of windings by insulating varnishes

Preheating of Work

Because these internal curing varnishes tend to increase in viscosity at elevated temperatures, the recommended procedure is to preheat the work in an oven, rather than in the impregnating tank itself. This procedure decreases the danger of thermal shock to the varnish, which might occur on coming into contact with a heated impregnating tank.

The preheated pieces should be transferred from the oven to the impregnating tank as quickly as possible to prevent cooling.

Vacuum and Pressure Conditions

After closing the cover of the impregnating tank, a vacuum of not less than 28 inches should be maintained for about one hour. After this period, varnish should be pumped from the storage tank to the impregnating tank until the work pieces are submerged.

After immersion, the impregnation chamber should be exposed to atmospheric or abnormal pressure. If abnormal pressures are necessary an inert gas is recommended. Units should remain in the varnish for approximately one hour.

Procedure will vary slightly for different types of windings. Recommendations for specific applications are available on request from Irvington.

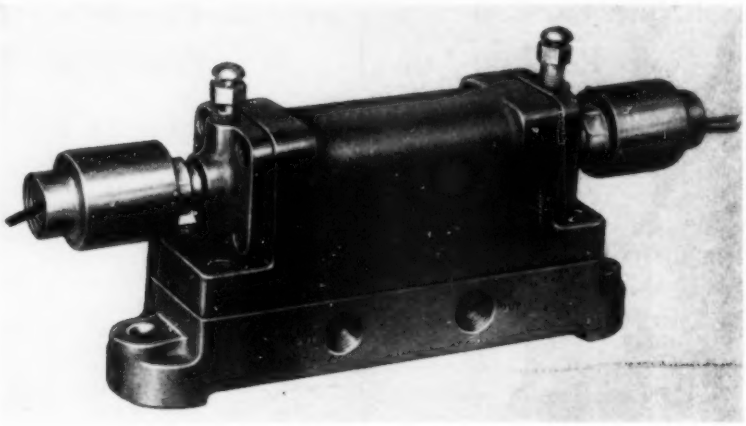
Design of Baking Oven Important in Results

Baking ovens for the curing of insulating varnishes should be provided with means for carrying off solvent vapors. A well designed ventilating system is required.

The oven should provide uniform, dry heat with proper temperature control. Gas, steam or electricity may be used as the means of heating. For increased curing speed in continuous-line production, infrared heating may be used, particularly for the curing of the internal drying types of varnish.

(For further information, write the Sales Manager, Varnish Dept., Irvington Varnish & Insulator Co. 10 Argyle Terrace, Irvington, N. J.)

Pilot-Operated Air Control Valves



Recently added to a line of air control valves is a pilot operated 4-way slide valve that can be pilot operated by cam, hand, or foot control poppets, or by solenoid pilots.

The type R (reciprocating) master valve unit (shown in the illustration) has a slide valve linked to a balanced piston with line pressure maintained on the inside, as well as on both ends of this piston. Exhausting air from either end of the piston by 2-way bleeder valves causes pressure on opposite end to shift the valve. Valve position is maintained until the air from the opposite end is bled. A wide pressure range of from 15 to 150 psi is possible.

The type AR (air return) master valve unit also has a slide valve but linked to an unbalanced piston. The inside of the piston is under constant pressure, and is shifted by admitting pressure to the large end by energizing a 3-way, normally closed solenoid pilot valve. Normal (return) position results when pilot valve is de-energized.

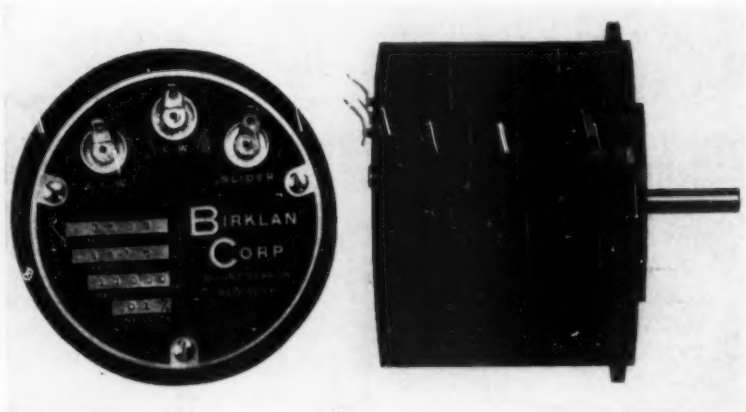
Both 2 and 3-way solenoid and bleeder valves are available for 110, 220, or 440 v a-c, or for d-c. Maximum operating wattage is 10.

There are no cored air passages in either of these types of valves. All air passages are precision drilled, giving full pipe area through the valve. The type R is available in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and 1 in. pipe sizes, and the type AR is available in $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ pipe sizes.

These pilot operated air valves are said to permit a wide variety of control applications because of their simple design and construction and small size, and light weight, resulting from the all-aluminum construction feature.

Galland-Henning, Nopak Div., 2753 S. 31 St., Milwaukee 46, Wis.

Precision Potentiometers Have Good Linearity



By calibrating against a standard accurate to 0.001 percent, and by using special winding techniques, this series 3,500 precision potentiometer has been developed having a linearity of 0.01 percent. The resistance range is 2,000 ohms to 300,000 ohms with a standard resistance tolerance of ±1 percent. Lower resistance values, down to 500 ohms are available at a reduced linearity of 0.02 percent. Temperature range of operation of the standard unit is 0 C to 80 C. Low temperature coefficient resistance wire (0.00002 parts per degree centigrade) and thermal cycling is used to stabilize resistance value. Depending on resistance value, the resolution is as great as 0.0024 percent.

Electrical and mechanical rotation may be specified to any value between 360 deg. and 3780 ±½ degree (linearity tolerance of 0.01 percent is based on 3600 deg. rotation). A traveling nut type limit stop is standard.

This unit may be servo or panel mounted. Its torque and inertia characteristics are adapted to servo requirements. The case is concentric with the shaft so that the unit may be cradle-mounted and driven differentially.

General specifications—Number of turns: 10; Power rating: 8 watts; length of coil: 90 in.; Starting torque: 1.0± 0.5 in.-oz.; Running torque: 0.5± 0.5 in.-oz.; Moment of Inertia: 54.3 grams per centimeter squared.

Birklan Corp., 200 E. Third St., Mount Vernon, N. Y.

CONTINUED ON PAGE 226

NEED MORE INFORMATION OR LITERATURE ON . . .

. . Products Appearing in the Advertising Pages?

WANT COPIES OF THE LATEST CATALOGS AND BULLETINS ON . . .

. . Metals, Rubber, Plastics, Finishes?

. . Mechanisms, Instruments, Electrical Devices?

. . Hydraulic or Pneumatic Components, Motors, Controls?

. . Other Types of Equipment and Engineering Materials?

READER SERVICE

KEEP UP TO DATE

Every month Product Engineering lists scores of new catalogs and bulletins available from manufacturers. Some of these cover features of specific equipment. Others contain detailed technical information on selection and application of broad classes of products. All are available to you for the asking.

USE THIS CARD

★ For copies of any manufacturers' bulletins described in this issue, circle postcard number.

★ For additional information on advertised products, fill in numbers of the pages on which products appear in spaces provided on postcards. If more than one product appears in the advertisement or if more than one advertisement appears on a page, indicate by name or initial the item in which you are interested. Write in name if pages are unnumbered.

Product Engineering Not good after 12/1/53

Please send complete information about the products advertised on the following pages:
(If more than one product is advertised on a page, indicate one in which you are interested.
If no page number is indicated, write in name of advertiser.)

....

....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

Name.....Title.....

Company.....

Address.....10/53

Product Engineering—A McGraw-Hill Publication

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager
Product Engineering
330 West 42nd Street
New York 36, N. Y.

READER SERVICE

. . . for your convenience in requesting new product catalogs and bulletins

. . . or further information on products advertised in this issue

Postage Will be Paid by McGraw-Hill Pub. Co.

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager
Product Engineering
330 West 42nd Street
New York 36, N. Y.

Product Engineering Not good after 12/1/53

Please send complete information about the products advertised on the following pages:
(If more than one product is advertised on a page, indicate one in which you are interested.
If no page number is indicated, write in name of advertiser.)

....

....

Send copies of the new bulletins and catalogs circled below to my attention.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

Name.....Title.....

Company.....

Address.....10/53

Product Engineering—A McGraw-Hill Publication

Getting all the information about all of the significant new developments in the design field every month is a tough . . . and time consuming . . . job. To save you time, the editors of Product Engineering screen scores of new catalogs and bulletins each month, select only the ones they know will be of interest to you, and summarize each for your convenience. The companies issuing these catalogs welcome your request for copies.

To save you time in making such requests, simply use one of the attached post cards.

For catalogs and bulletins, simply circle on the post card the numbers which correspond to those that accompany our editors' listings and descriptions. Our Reader Service Department will do the rest.

Also use this same card when you want additional information on any products advertised in this issue.

Just write, in the spaces provided, the numbers of the pages on which the products in which you are interested are advertised.

PLEASE USE ONE CARD ONLY . . . so that this service may also be available to other men in your company who may read this same copy of Product Engineering.

To be sure that your request will receive prompt and careful attention, please write or print legibly your name, company affiliation, and address. This service is valuable to you only if you use it. We welcome your comments and suggestions at any time.

Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

Here's a bearing that can be "custom-engineered" to your exact requirements

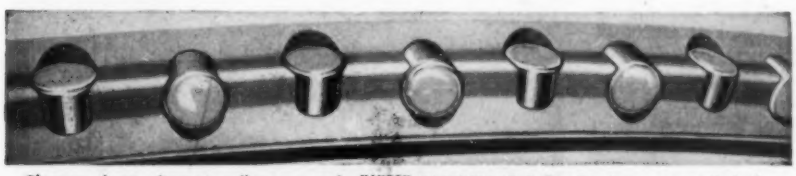
KAYDON BI-ANGULAR Roller Bearings are adaptable to various proportions of thrust and radial loads

IF you've design problems involving various combinations of thrust and radial loads, you don't have to buy separate radial bearings and separate thrust bearings.

KAYDON BI-ANGULAR Roller Bearings normally are built with every other roller reversed, and in such cases, adjacent rollers are at 90° to each other to carry both thrust and radial loads.

To handle thrust loads greater from one direction than the other, the bearing can be made with every second, third or fourth roller reversed, depending on the load inequality.

Whatever *your* bearing needs, KAYDON has all the facilities your engineers require. Whether it's only a few or many special bearings — 4" to 120" outside diameter — or millions of high-precision rollers — contact KAYDON for confidential counsel and cooperation.



Close-up shows alternate rollers reversed. KAYDON BI-ANGULAR Roller Bearings are particularly suitable for low-speed applications involving heavy impact loads.

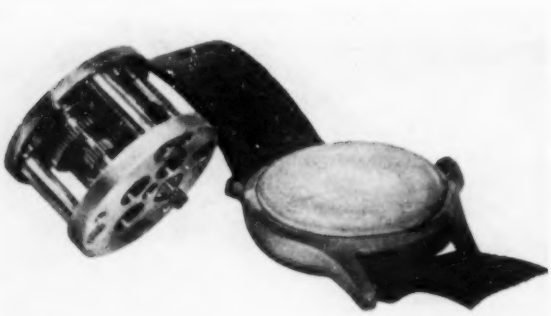
31.000" x 34.988" x 2.000" KAYDON BI-ANGULAR Roller Bearings have been produced in large quantities and are successfully in use. They are further proof of KAYDON ability to design and make unusually large precision bearings for specific needs.

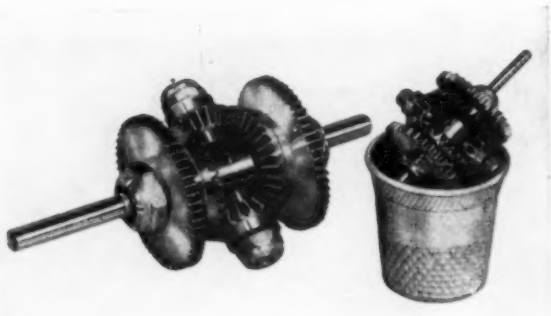
THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
• Roller Radial • Roller Thrust • Bi-Angular Bearings

PRECISION BALL AND ROLLER BEARINGS





Sub-Miniature Gears For High Accuracy

The $\frac{1}{16}$ in. sub-miniature differential shown at right is designed for application where accuracy must be maintained in a minimum of space. The end gears are available in 64 or 96 pitch, and any pitch diameter which can be cut from a $\frac{1}{2}$ in. maximum outside diameter to $\frac{1}{4}$ in. minimum root diameter. All gears are phosphor bronze to give maximum life of the differential.

The 20 deg. coniflex tooth form is used with subsequent assembly lapping for fine tooth to tooth action. Minimum backlash combined with low breakaway and running torques give the differential high accuracy for a unit of this type and size. Some of the specifications are: Breakaway torque, 0.15 in.-oz.; Maximum torque, 12 in.-oz.; Maximum rpm, 600; Backlash 18 minutes.

This miniature gearbox shown at left features a stainless steel construction, with ball bearings used throughout. The unit is designed to meet aircraft vibration specifications and when requested, it can be supplied with any potentiometer having a $\frac{1}{8}$ in. shaft to form a packaged miniature servo system. Integrally cut cluster gears reduce backlash to a minimum.

The following data was taken while the unit was operating on standard 28 volt aircraft supply: Output torque, 8 oz.-in. with maximum backlash of 0.007 in. at the input; Starting voltage 1.5 v, and will operate in temperatures ranging from minus 65 C to plus 125 C. The life expectancy of this gearbox is 2000 hrs. under normal applications and running conditions. The present design is for a 300:1 ratio. Other ratios will be supplied, and the unit may be designed for operation with an 18 v power supply.

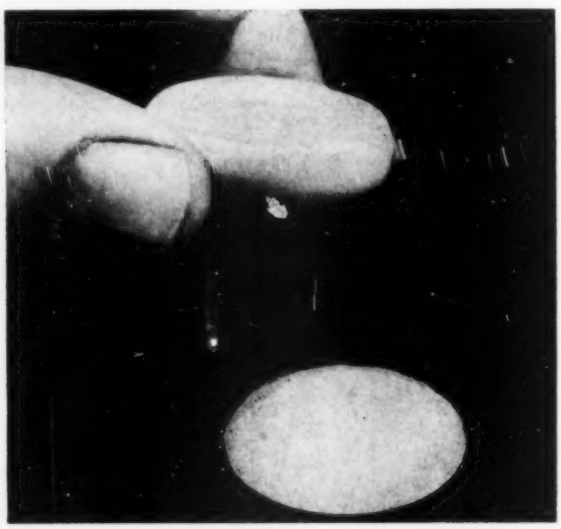
Belock Instrument Co., College Point, New York

Silicone Rubber Parts Have Small Shrinkage

Silicone rubber parts are being produced in molds originally designed for natural and synthetic rubber parts, according to this manufacturer who has developed a low compression set rubber with only half the shrinkage after molding of conventional silicone rubber compounds.

Recommended particularly for capacitor bushings and for O-rings and packings in engines where gaskets and seals must remain effective under sustained pressure, the new compound has a compression set of only eight percent after 22 hours at 300 F, as compared with nearly 100 percent for organic rubber and about 75 percent for general purpose silicone rubber. Its water absorption is one percent after immersion for one week at 70 C.

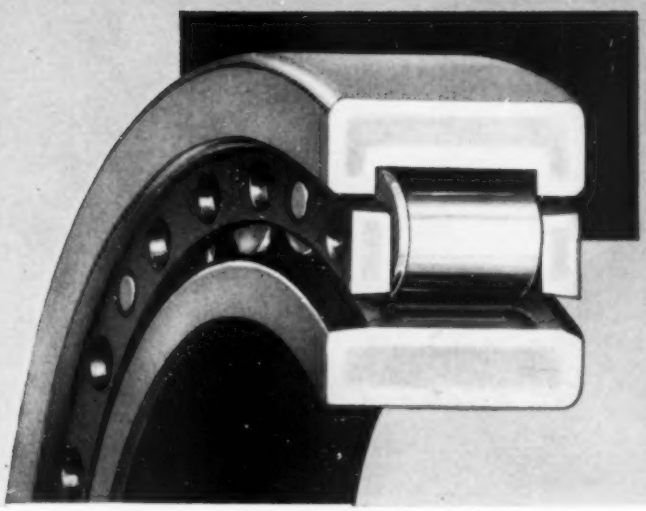
The illustration shows the low compression set (eight percent) of the SE-360 silicone rubber as compared to general purpose silicone. Both molded discs were compressed 50 percent and baked for 22 hours at 300 F. After removal from the oven and release of pressure, the general purpose material recovered only ten percent of its original height while SE-360 recovered 92 percent.



General Electric Co., Chemical Div., Pittsfield, Mass.

CONTINUED ON PAGE 228

Bower straight roller bearings carry maximum loads!



TWO-LIP RACE INCREASES RIGIDITY— IMPROVES ROLL ALIGNMENT

Examine the cutaway view of the Bower straight roller bearing, shown above. It is important to note particularly the two parallel lips made integral with the outer race. These lips or shoulders provide a rigid, durable construction—keeping the rolls in proper alignment.

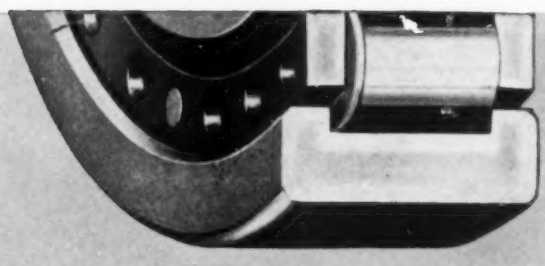
Built of highest quality materials, Bower straight roller bearings have proved themselves capable of standing up day in and day out under maximum loads and the most rugged conditions—with virtually no maintenance whatsoever. They are used extensively in such fields as automotive, earthmoving, farm equipment and heavy machine tool. For the aircraft industry, Bower builds straight roller bearings—especially designed for high-speed, high-temperature operation—which are used by virtually every producer of jet engines.

Whatever you manufacture, you'll build a better product with Bower roller bearings. Write to Bower today. A Bower engineer will give you full details of the complete Bower line.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

BOWER

ROLLER BEARINGS



A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

Hysteresis Variable Speed Drive Units

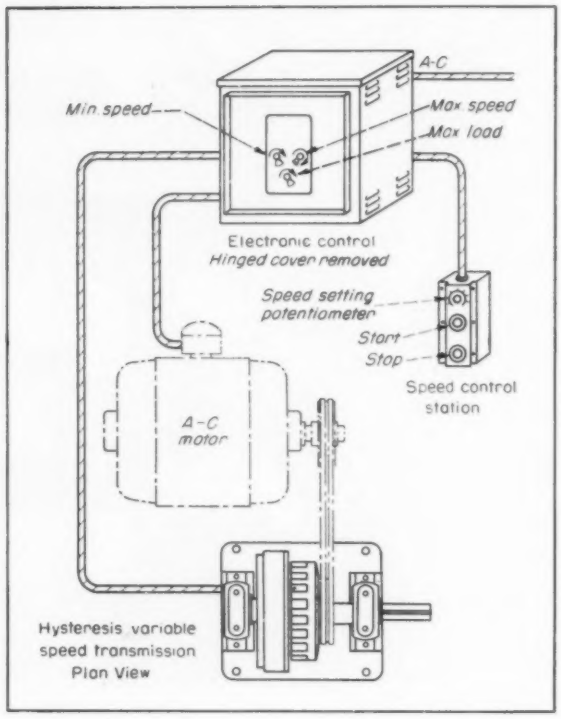
Hysteresis clutches, used with a-c motor drives, eliminate the necessity for motor-generator sets used with d-c motors in heavy duty applications, and give smooth stepless speed variation up to full motor output rpm. Torque control is obtained through regulation of the amont of d-c to the clutch oil. As the torque input to the clutch is a function of the current being used by the a-c motor, a current transformer can be wired into one lead of the motor, and the variation in the output of this transformer used as a reference to regulate the current in the clutch coil.

Full torque is available at all speeds, and pre-set speeds, regardless of load variations may be accurately maintained. The speed range ratio of 9 to 1 applies to all clutch sizes. No water cooling is required.

Full overload protection is inherent in the hysteresis clutch design, as the clutch is capable of 100 percent slip without appreciable heating.

Among the applications for magnetic type clutches are the following—Conveyors: For preset speeds, synchronization, balancing loads for multiple drives, and in the case of hysteresis, complete overload protection; Presses: Output can be increased (perhaps 20 to 30 percent per hour) by timed rate acceleration and speed cycling; Grinding Machines: Faster work by extreme range of speed control; Textile Field: For looms and spinning machines; Constant Tension Devices: Tension and compression can be synchronized. Extrusions, and chemical mixes can be accurately controlled. In general, the manufacturers claim that the performance of many types of motor driven machines can be improved with hysteresis clutches.

The hysteresis clutch is available from 1½ to 20 hp, for both integral combination motor-drive units in one housing, and transmission type units with separate motors.



June & Co., 505 New Center Bldg., Detroit 2, Mich.

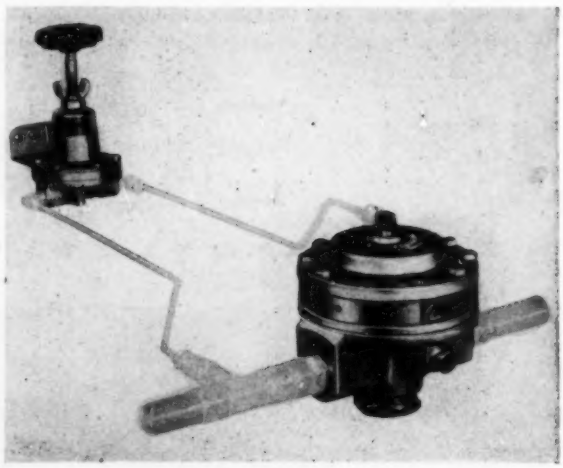
Precision Air Pressure Regulation Over Wide Range

Continuous and precise control of air pressure from 2 psi to 120 psi with a capacity to deliver more than 200 cfm are some of the features of this new pilot-controlled air pressure regulator. This device uses regulated air pressure to control delivered air pressure, minimizing the effect of fluctuating line pressure as a factor in delivering uniform air pressure.

A light adjusting spring in the pilot control regulator makes regulation easy and eliminates heavy adjusting springs. This new regulator is available in ¼, ⅜, and 1 in. sizes.

The control pressure is continuously maintained by the pilot regulator. There are no sealed pressure chambers that will leak, and ambient temperature changes do not affect regulated delivery pressure because of the pilot regulator control.

The regulator can be located at any desired point in the air line system regardless of accessibility, with the pilot control regulator installed at a convenient location. The connection between the pilot control regulator and pressure regulator is either $\frac{1}{16}$ or ¼ in. O.D. tubing. Another advantage is the relieving feature which facilitates accurate control of the pressure when used on dead end service.



C. A. Norgren Co., 3400 S. Elati St., Englewood, Colo.

CONTINUED ON PAGE 230

LOOK TO THE LEADER... FOR LUBRICATING DEVICES GITS

40 YEARS' LEADERSHIP

Yes, for 40 years GITS has been setting the standard for industry . . . solving tough lubricating problems . . . earning the confidence of manufacturers . . . it's the reason people say, "Call GITS first".

LOW COST

Yes, GITS oil cups can do a complete lubricating job for you . . . prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production . . . and GITS oil cups cost so little.

WORLD'S LARGEST SELECTION

Yes, only GITS can offer you such a wide range of standard stock sizes. From *just one* source you can get *all* lubrication devices in *any design* for *any purpose.*

CONSISTENT TOP QUALITY

Yes, GITS is known for uniform quality in design, materials and machining . . . this means constant, dependable performance for you. Inferior products can cost you time and money. Demand the best . . . get GITS.

Oil Hole Covers • Oil Cups • Grease Cups • Bottle Oilers • Gauges • Gravity-Feed • Wick-Feed
Constant Level • Vibrating Rod Styles • Threaded or Drive-Type • Elbow or Straight

GITS BROS. MFG. CO.

1838 S. Kilbourn Ave. Chicago 23, Ill.

Write today for Free Catalog No. 60A. Use it as your handy reference for lubricating devices.

Accurate, Pocket-Size Hardness Testers

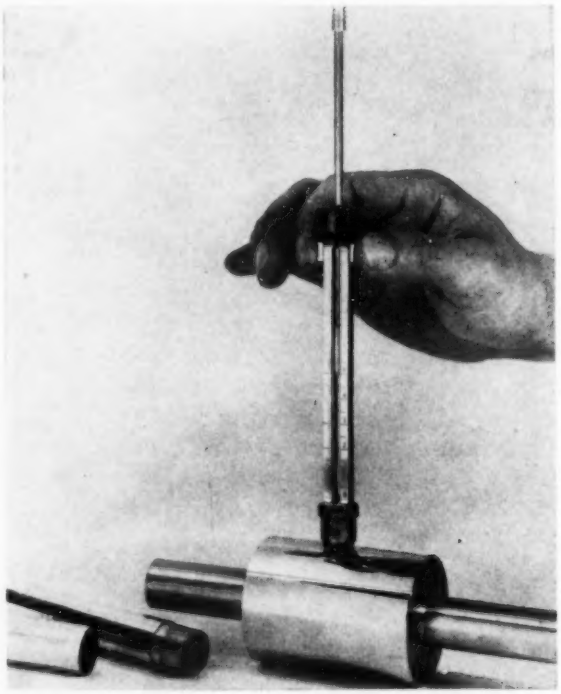
Small, pocket-size hardness testers operating on the rebound principle simplify the testing procedure, while giving accurate test results. The testers, known as Sklerografs, are operated by placing it in a vertical position on top of the article to be tested, and the rebounding bar, which carries a hardened steel ball point, is raised until held in place by the locking device. When the locking device is released by pressing a catch, the bar falls and rebounds to a point corresponding to the hardness of the object, where it is retained. Hardness can then be read within an accuracy of 1 point Rockwell C., by noting the position of the indicator ring on the hardness bar against the graduated scale. Conversion tables supplied with the tester are used to convert the scale reading to Shore, Rockwell C, Rockwell B, or Brinell hardness.

Objects weighing four pounds or more require no special provision for testing. Smaller objects, such as small machine parts, tools and sheets, should be placed on a steel block.

Two models are available. Model M weighs 5¼ oz, including the tubular nickel container, which is 6½ in. long and ¾ in. in diameter. This model leaves no indentation on the surface of the material tested, and therefore may be used on finished pieces.

A somewhat larger type, model D, which is designed to withstand the rougher usage likely to be encountered in shop practice measures 7¼ in. long by 1 in. in diameter; weight of the instrument and container is 9 ounces. This model leaves a small indentation on the surface.

These portable hardness testers have found use in: rolling mills; grinding and polishing shops; forging, casting, and welding; the manufacture of dies and molds; and others.



Kurt Orban Co., Inc., 205 E. 42 *St., New York* 17, *N. Y.*

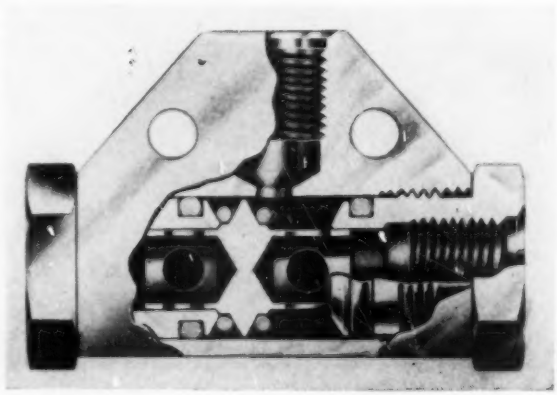
Wide Pressure Range Precision Shuttle Valve

Precision shuttle valves, designed to provide automatic switchover from either of two control stations, allowing for control from each, may also be used as breakaway valves to switch over automatically from the normal source of pressure to an emergency source, as in truck and trailer braking systems.

Among the features of the valves is the sensitive shuttling action with dead-tight sealing at pressure differentials of from less than ⅓ psi to 3000 psi. Good sealing efficiency is achieved by a circle seal principle developed by the manufacturer which makes use of a free floating O-ring as a sealing member between conical metal seats. Shuttling pressure differential for this action is only a few inches of water.

These new shuttle valves are designed for almost any type service from 0 to 3000 psi, ranging from very low pressure instrumentation circuits to high pressure pneumatic or hydraulic circuits. They are offered for liquid flow rates up to 5 gal per min., and for gas flows to 20 cfm. Valves in this series are normally furnished in aluminum with ¼, $\frac{5}{16}$, ⅜ or ½ in. tube connections, or they can be supplied in brass with ¼ or ¼ in. female pipe connections.

Used as pressure balancing valves, lightweight, accurate, low-pressure relief and vent valves are also available from the manufacturer, to prevent over pressuring and under pressuring of containers holding sensitive equipment.



James-Pond-Clark, 2181 *E. Foothill Blvd., Pasadena* 8, *Calif.*

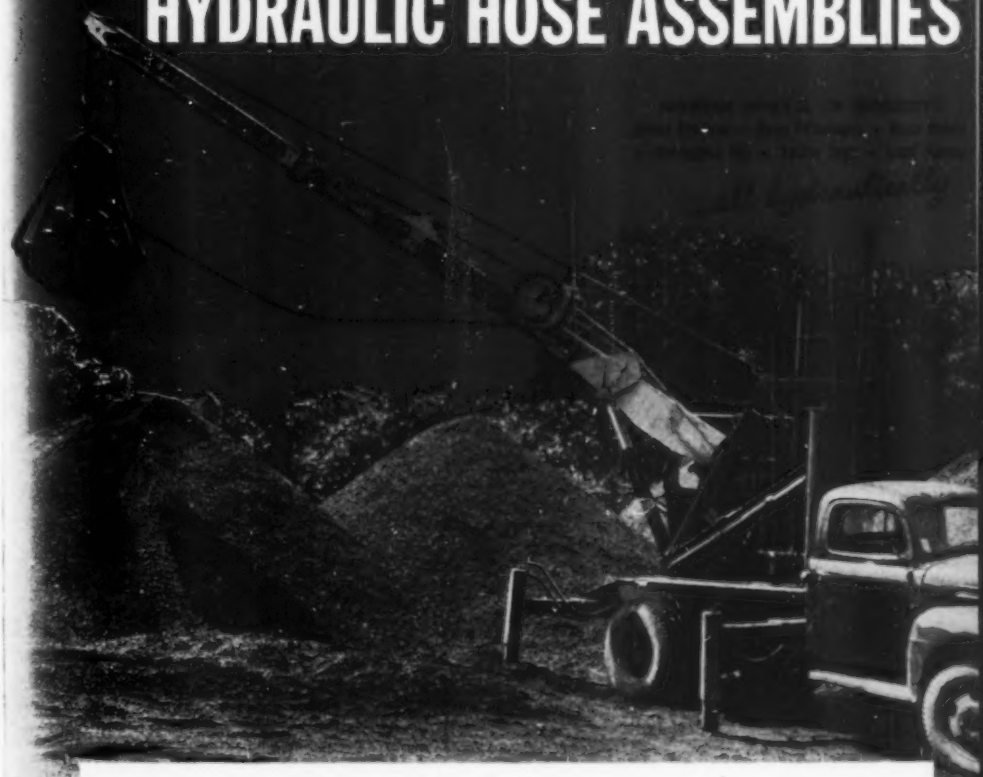
CONTINUED ON PAGE 232

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

6 HYDRAULIC MOVEMENTS OF BUCYRUS-ERIE HYDROCRANE RECEIVE POSITIVE POWER THROUGH . . .

Eastman

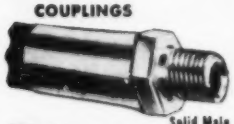
HYDRAULIC HOSE ASSEMBLIES



Specify
Eastman
first in the field
HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS



Solid Male

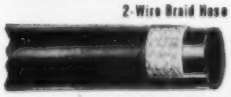
Swivel Male

Swivel Female

HOSE

1-Wire Braid Hose

2-Wire Braid Hose



1-Fabric Braid Hose

2-Fabric Braid Hose

Spiral Wire Hose

Write for free catalog 100 on Eastman hose couplings and fittings.

Positive, unfailing hydraulic power is delivered to six basic motions on many Bucyrus-Erie H-3 Hydrocranes through dependable Eastman Hydraulic Hose Assemblies.

Eastman, *first in the field* of Hydraulic Hose Assemblies, pioneered in many original applications of mobile hydraulic power. As early as 1926, J. Peter Eastman experimented with wire braided hose.

Continued Eastman developments have made it possible to apply *more* power, over *greater* distances, through *higher* pressures—until today, 6,500 psi are withstood by the Eastman 3-wire braid hose assemblies used on many Bucyrus-Erie H-3 Hydrocranes.

Take advantage of our 25 years of experience in the application of mobile hydraulic power to manufacturer's original equipment. Engineering consultation on special problems is our specialty . . . complete service yours to command.

Eastman
MANUFACTURING COMPANY
Dept. 7510, Minneapolis, Minnesota

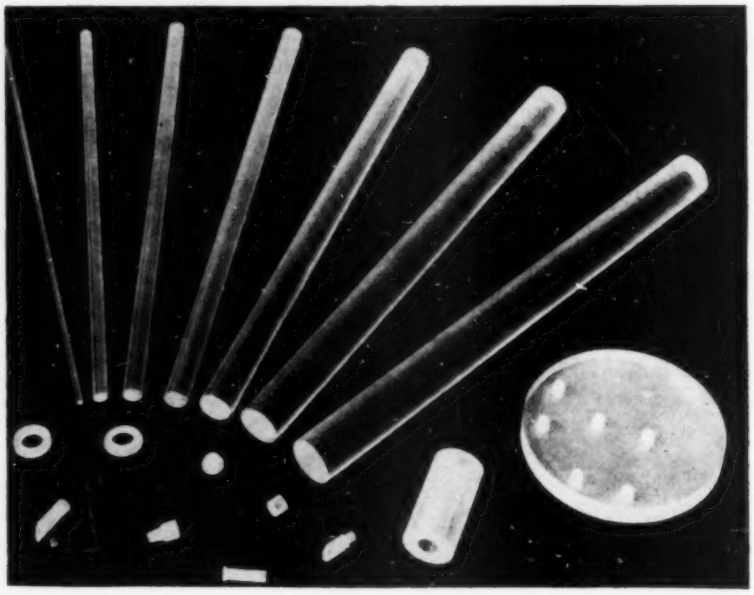
Industrial Plastic For Ultra-High-Frequency Use

Developed as a lower cost ultra-high-frequency insulating material with good heat resistance and excellent machinability, an industrial plastic known as Polypenco Q-200.5 is being used for electrical, electronic, communication, and similar equipment where a stiffer material than Teflon is required. Applications have been successful for such items as coaxial spacers, UHF antenna insulators, stand-off insulators, coil forms, and connector beads.

Polypenco is a rigid, clear and transparent heat hardening polymer with a low dielectric constant of 2.4 to 2.5. It shows only a slight change in the dissipation factor (less than 0.0002 in. at 30 megacycles) over the entire frequency range. The rigidity of the material makes it suitable for applications where other insulators were not satisfactory because of cold flow characteristics.

Insulators made from this material are said to withstand temperatures up to 400 F under light load conditions. The heat distortion temperature is 220 to 225 F at a 264 psi fibre stress.

Because of its good machinability, the material can be drilled, turned, milled, ground or polished to close tolerances on automatic or semi-automatic metal-working equipment. The same tools as those used in cutting brass are recommended. Where a high polish is required, it is best to use a lubricated cloth buffing wheel.



Polypenco Q-200.5 is available in rod shapes of $\frac{1}{8}$ to 1 in. in diameter, and in lengths of 6 to 8 feet.

The Polymer Corp. of Pennsylvania, Reading, Pa.

High Temperature Encapsulated Selenium Rectifiers

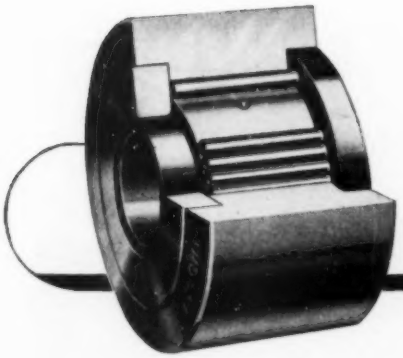
Completely encapsulated as a self-contained unit operating at normal voltage and current ratings, these selenium rectifiers in a special casting resin will withstand thermal shock as well as have good heat conductivity. Also, the contact of all the cells of the stack enables the stack to be exposed to temperatures ranging from —55 C to 150 C. Although it is not advisable to expose the rectifier itself to this high temperature, it is possible to use not only the normal stack but also the high temperature stack, which may be operated at 125 C. Ratings are from 5 ma to 3 amps with voltages up to 4,000 v rms.

Where a combination of rectifiers is involved, several rectifiers can be encapsulated in a single unit, giving compactness of design. In addition, the encapsulated rectifiers can be provided according to any mounting specification.

Depending on the size of the rectifier to be encapsulated, increase in weight can be considered to be about 3.5 times the weight of the original unit. The casting resin used has good dielectric properties.

Radio Receptor Co., 251 West 19th St., New York 11, N. Y.

CONTINUED ON PAGE 234



How to increase the versatility of cam follower applications

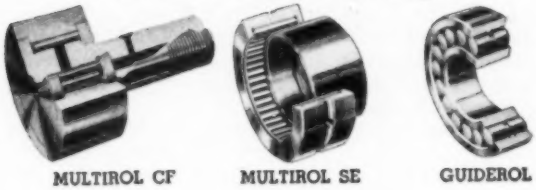
The ever increasing number of cam action applications in modern machinery is partially responsible for insuring greater efficiency and productivity through increased automatic operation. Helping to make this possible is the availability of a precision means of converting motion originating through cam action to adjacent mechanisms with an adequate anti-friction cam follower bearing.

The first such bearing acceptable to machine builders was produced by McGill and is now used extensively in all types of automatic machinery. The MULTIROL Cam Follower design requires mounting by means of securing the stud, leaving the anti-friction roller free to follow the cam.

Another more recent McGill development in cam follower design is the MULTIROL CYR series bearing that uses an inner race rather than the conventional stud. The bearing is sealed with roller retaining end plates tightly fitted and secured to the shoulders of the inner ring. Yoke mounting is possible where desirable with the CYR bearing on shaft sizes ranging from ¼" to 1¼" for corresponding roller diameters of ¾" to 4".

The CYR series bearing is non-separable with a thick outer race section to withstand the heavy shock load encountered on all types of cam applications found on automatic machinery. This heavy duty bearing is not only suitable to direct cam action over a wide speed range but it can be applied as a means to control motion of machine parts that require guide or support rollers. Examples include lathe or planer beds, welding machine heads, aircraft wing flaps, wire straightening rollers, etc.

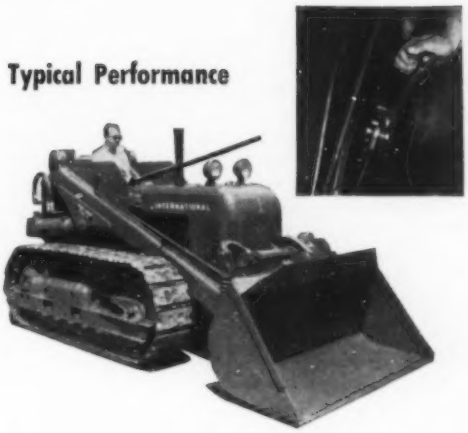
Other McGILL® Bearings



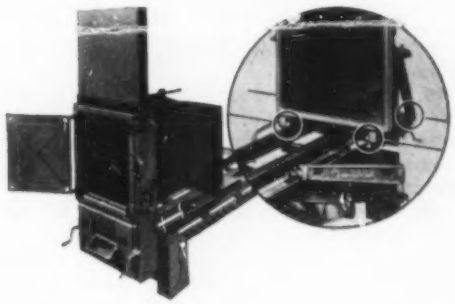
MULTIROL CF | MULTIROL SE | GUIDEROL

A new 140 page Bearing Reference Guide complete with 30 pages of vital engineering data has just been released by the McGill Manufacturing Company. It has the full story on the advantages of MULTIROL CYR Bearings as well as information on MULTIROL CF and SE and GUIDEROL Bearings. Send now for your copy of McGill Catalog No. 52.

Typical Performance



Bucyrus-Erie Company, South Milwaukee, Wisconsin uses MULTIROL CYR series bearings as quadrant rollers on the operating lever that controls the bucket on their TD-9 one yard Dozer-Shovel. These bearings allow easy and free lever motion as they ride the quadrant cam in one of four positioning pockets. McGill GUIDEROL bearings are used in the PVT hydraulic unit on this same Dozer-Shovel.



Typical of the varied uses MULTIROL CYR bearings can satisfy are the track rollers on the highly precision Process Copy Cameras built by Consolidated Hammer Dry Plate and Film Company of Chicago, Illinois. Here four CYR bearings support and guide the copy board along rails before the camera. These bearings permit free and accurate adjustments for sensitive camera focus.

McGILL® —Precision Bearings

McGILL MANUFACTURING COMPANY, INC.
201 N. Lafayette Street, Valparaiso, Indiana

High-Speed Digital Voltmeter

This digital voltmeter for indicating (in decimal or binary numerical digits) voltages with secondary standard accuracy over a wide range of inputs, has such features as: (1) High speed up to 100 separate readings per second can be obtained, without use of stepping switches or a servo-driven potentiometer; (2) Four digit in-line read-out to indicate the measured voltage with an error less than 0.1 percent of the input reading, or 0.00075 v, whichever is greater; (3) High input impedance—10 megohms; (4) Decimal point shifts automatically with no manual range switching to provide a continuous range from 0.001 v to 999.9 volts.

In addition, the unit is non-cyclic in operation—it will follow continuous changes either up or down in input voltage. There is instant verification of calibration through a front panel switch which momentarily connects an internal standard voltage cell to the voltmeter input.

The instrument compares the input voltage with a variable reference system. If a difference occurs, the reference is made to balance the input through a logically sequenced millisecond relay computer. This type of voltmeter is available in models having outputs that are designed for applications as operating electric typewriters or other storage devices, and with automatic polarity indication.

Non-Linear Systems, Del Mar Hotel, Del Mar, Calif.

Indicating Switch Detects Fluid Flow

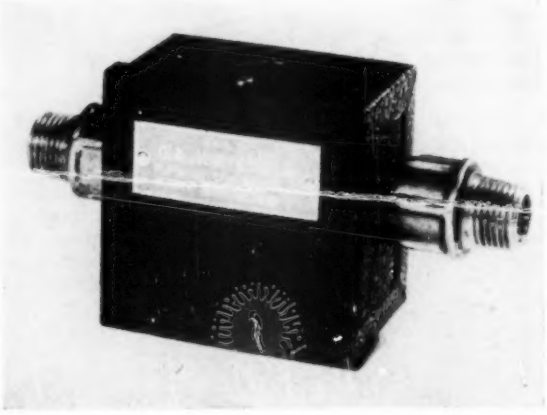
Electrical circuits for signalling flow or non-flow of liquids through pipe lines can now be controlled by means of a magnetically coupled flow-indicating switch. The new device is suitable for use with water and other liquids not harmful to brass or copper.

Flow is sensed by a movable vane positioned within the flow tube. Variation from the desired rate of flow causes a chrome-plated Alnico magnet, attached to the movable vane, to actuate the contacts of a mercury magnetic tube positioned outside the flow tube. The device is constructed with ½ in. IPS brass fittings for easy installation directly in a flow line.

Two models of the switch are available. One model allows a maximum flow of 2.5 gpm through the flow tube, and can be adjusted for flow sensitivity of 0.1 to 0.6 gpm. The other model has an adjustment range of 0.25 gpm to 1 gpm and allows a maximum flow of 4 gpm. This control unit can be used in lines of greater capacity by installation of a by-pass and regulating valve arrangement.

Applications of the new device include indication of insufficient flow of water to water cooled bearings on large centrifuges, indication of insufficient flow of light cutting fluids on cutting machinery and boring mills, and to operate electrical shut-off valves for pumps and tank overflows.

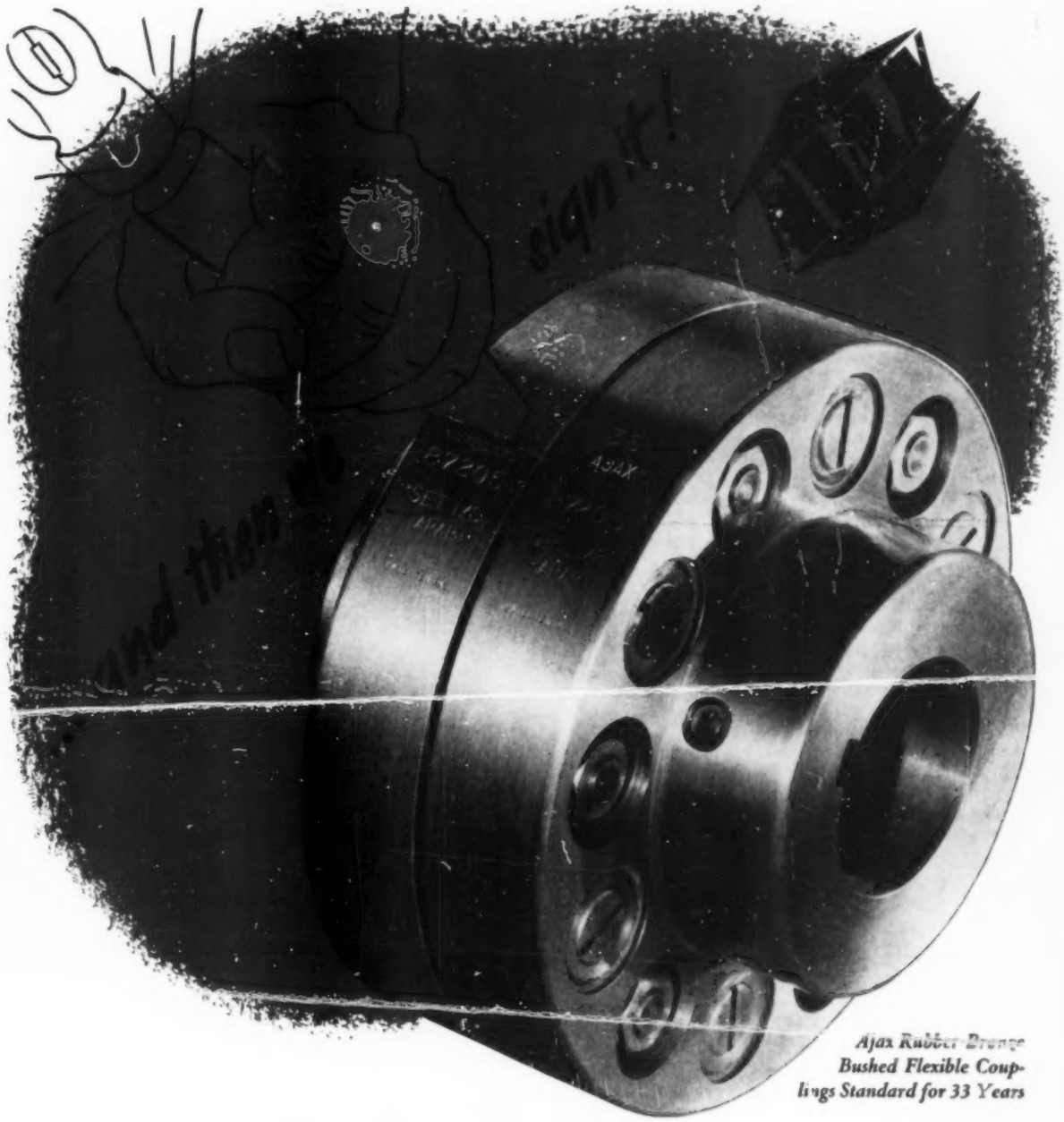
The flowswitches are also used as interlocks to prevent operation of spot welders, induction hardening machines, washing machines, radio broadcasting tubes, water cooled air compressors and air conditioning equipment unless water supply is turned on first.



Winterburn Mfg. Co., Putnam, Conn.

A PLASTIC SEALANT for impregnating pressure castings will permanently seal excessive "leaker" and "squirter" pressure castings, and is said to have good penetration properties, enabling it to saturate all porous areas. Upon hardening, the manufacturers claim that there is no loss from evaporation, and 15 to 50 percent less shrinkage than other plastic seals. The plastic seal may be washed off with water. Tincher Products Co., Sycamore, Ill.

CONTINUED ON PAGE 236



Ajax Rubber Flange Bushed Flexible Couplings Standard for 33 Years

● The final and one of the most significant operations in building Ajax Flexible Couplings is stamping the Ajax name and serial number permanently into every coupling. This Ajax signature and number represents the talent, craftsmanship and experience which are responsible for Ajax performance and economy.

It is proof that Ajax has not only built hundreds of thousands of couplings, but a reputation. Design engineers and maintenance men have learned that it pays to protect direct connected machines with these top quality couplings. Every Ajax coupling is entered on our records by its individual serial number. Analysis show that thousands of users over a 33-year period have found that maintenance cost is zero.

Furthermore, shut-down costs are cut to the irreducible minimum because of protection to bearings, armatures, impellers, and other expensive working parts. You will realize the importance of a good coupling when you remember that all the horsepower goes through the coupling. **Ajax knows couplings.**

AJAX

Write for New Catalog No. 55

AJAX FLEXIBLE COUPLING CO. INC., WESTFIELD, N. Y.

Flexible Joint Easily Assembled

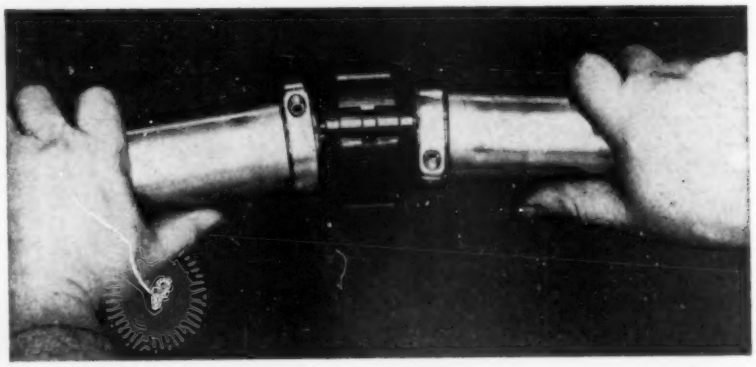
This flexible joint, designed primarily for use in the fuel systems of aircraft allows, for any deflections, vibration, expansion, and construction tolerances, while still maintaining fluid-tight connections.

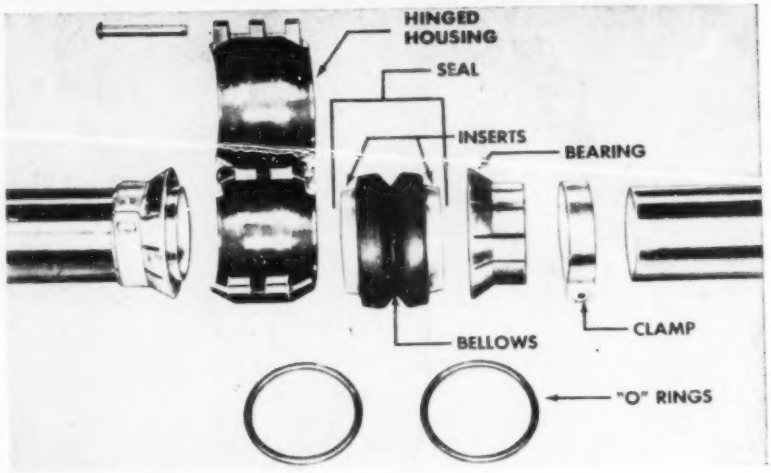
The heart of the connection, called the Flex Joint, is a synthetic rubber bellows bonded to aluminum inserts at both ends. Flexing and sealing are treated as two separate problems. The bellows permit relative motion of the inserts, and the inserts contain two O-rings to seal against the tubing. Completing the assembly are a pair of bearings and clamps, and a housing.

The joint has such advantages as: 1. No flaring or beading of the tubing is necessary; 2. Assembly can be made in confined spaces with ordinary hand tools; 3. The joint makes a compact, fluid-tight seal under all conditions; 4. It permits angular movement of plus or minus 10 degrees; 5. It accommodates axial misalignment of tube ends up to $\frac{1}{16}$ inch; 6. It allows for axial thermo-expansion of the tubing; 7. It dampens high frequency vibrations; 8. The seal and O-rings can be easily replaced without use of tools.

The two inch joint is now available; with sizes to accommodate 1 in. through 4 in. tubing to follow.

Aeroquip Corp., Jackson, Mich.



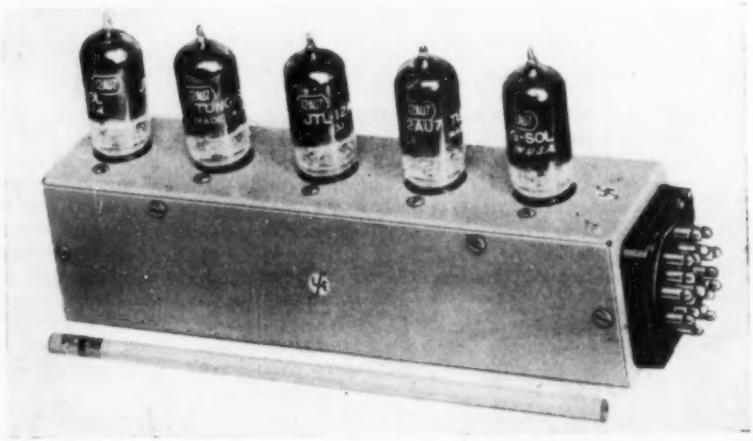


Magnetic Binary Counter in Plug-In Package

Suitable for a wide range of counting functions, this new magnetic 9-stage binary counter plug-in package capable of counting at rates up to 50 kc, has been designed to include a minimum of components in a unit measuring only 8 x 2 x 2 in. in size. Features are: low power requirements; wide tolerance on power supply variations; and minimum number of tubes.

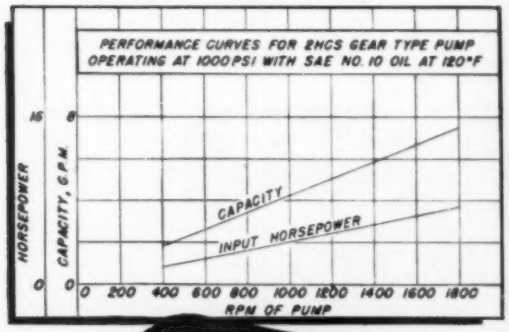
Called the model 1001, its major applications are those relating to pulse rate scaling and digital control system. It can be applied to perform such functions as integration, addition, multiplication and division when used with other plug-in packages.

Laboratory For Electronics, Inc., 75 Pitts St., Boston 14, Mass.



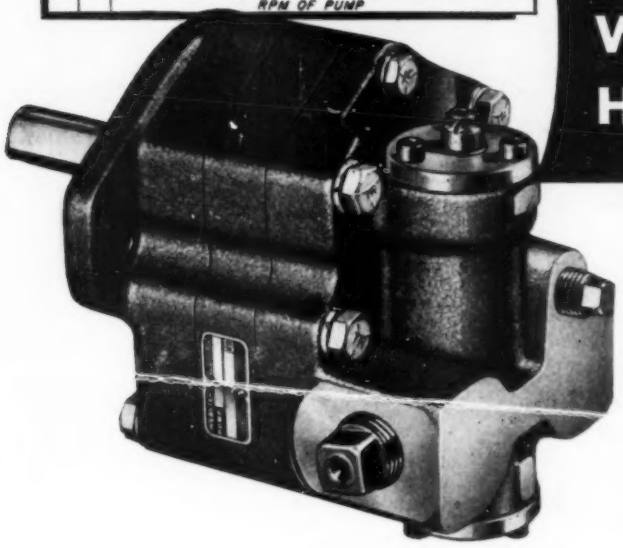
CONTINUED ON PAGE 238

TYPICAL PERFORMANCE CURVE



For PROVEN PERFORMANCE and LOWEST COST

check the WEBSTER Line of Hydraulic Pumps



CHECK THESE FEATURES

- ✓ Exceptionally compact design.
- ✓ Wide selection of porting locations and mounting methods.
- ✓ Integral relief valve optional.
- ✓ Gear contour carefully selected for quiet operation.
- ✓ Shaft design to accommodate various driving mediums.
- ✓ Engineered and precision-built for economical performance.
- ✓ All materials carefully chosen for durability.
- ✓ Design permits use in pumping other liquids having a substantial oil base.

● It will pay you to get the facts about Webster Gear-Type Hydraulic Pumps before buying *any* pump. Here is a *complete line* of rugged, dependable pumps from 10 gph. to 10 gpm., engineered to operate efficiently at pressures up to 1000 psi. at speeds of 3600 rpm. or less—90 pumps of various designs and capacities to meet the widest range of requirements!

Webster pumps are the product of skill acquired during nearly a quarter-century of experience. They have established an enviable reputation for efficient, dependable operation. All Webster pumps lend themselves readily to many forms of adaptation—and to modification for special installations. All are available with built-in relief valve, if desired.

Whenever you require pumps for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications, we invite your inquiries. There is no obligation; just fill in and mail the coupon for further information.

Oil Hydraulics Division, Webster Electric Company
Dept. PE-10, Racine, Wisconsin

Send me information on WEBSTER Hydraulic Pumps as checked:

Capacity (approx.) _____ G.P.M.
Pressure (approx.) _____ P.S.I.
Pump Speed _____ R.P.M.

Name and Title _____

Firm Name _____

Street Address _____

City _____ Zone _____ State _____

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE WISCONSIN

"Where Quality is a Responsibility and Fair Dealing an Obligation"

WEBSTER ELECTRIC COMPANY, RACINE, WISCONSIN • EST. 1909

Two-Stage Hydraulic Torque Converter

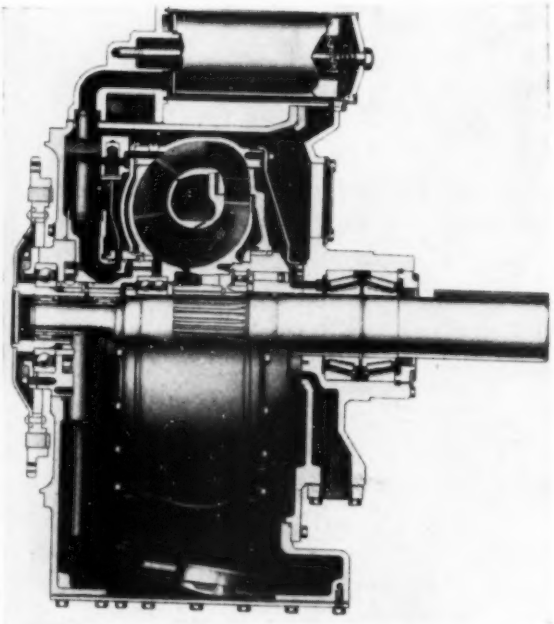
Providing maximum operational efficiency, the new two-stage torque converter shown develops up to 4:1 torque multiplication at stall, combined with progressively increasing engine speed during acceleration and uniform pull-down under load. This meets the requirements of certain engine applications needing converter drive with specific performance characteristics.

The principal feature of the new converter is its free-wheel reaction or stator blades, which permit complete unloading of the engine at high speed, no-load conditions—with low horsepower absorption for greater economy, and with minimum cooling requirements.

The basic two-stage converter unit is the model S, which offers a standard spider drive input, and is equipped with a built-in converter charging pump around the input shaft, just adjacent to the drive spider. Inlet and outlet connections are provided for piping the converter fluid to and from a cooler, which can be either an oil-to-water heat exchanger, or an oil-to-air radiator.

Two types of output shafts will be available: (1) straight shaft extension type, which will be mounted on maximum bearing centers and have an adequate rear housing to handle side loads; and (2) flanged shaft type, to permit use of a U joint connection for in-line drives.

Also, the new converter has been designed in a disconnecting type, called the model SD. Essentially the same as the basic model S unit, the model SD incorporates the additional design features of: (1) quick-release dump valves on the rotating turbine wheel, to permit release of the oil within the converter circuit—providing a complete disconnect feature; and (2) a 2-position control valve, which is located on top of the stationary converter housing —used for the actuation of the dump valves.



Compact in size, the model SD's overall length is said to be less than a converter equipped with a conventional friction clutch between the engine and a converter.

Twin Disc Clutch Co., Hydraulic Div., Rockford, Ill.

Combination A-c-D-c Aircraft Relay

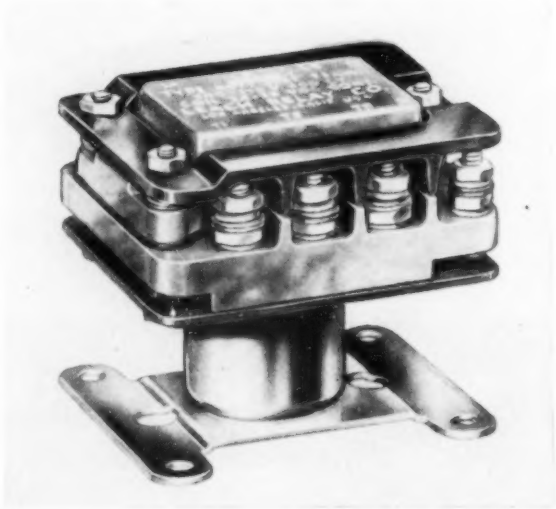
A compact, rugged, lightweight, heavy duty, dual-purpose relay has been designed specially to operate a-c or d-c electrical systems in aircraft, such as 3 phase 400 cycle power systems on motors, NESA electrically heated windshields, and other devices. It meets all high shock, vibration, acceleration, altitude and temperature requirements.

The contact arrangement is three pole single throw a-c, or single pole single throw d-c, normally open. Rating—rated load per pole 120 v d-c or 200 v a-c 400 cycles. Resistive (400 cycles 200 v a-c) 25 amps. Resistive, inductive and motor load 25 amps at 29 v d-c. All poles are connected in series.

The coil is 100 ohms, 24 v d-c continuous duty. Pick-up, 18 v d-c max.; Drop-out, 7 v d-c + 0, —5.5.

Dimensions are length $3\frac{1}{64}$ in., height $2\frac{3}{4}$ in., width $2\frac{31}{32}$ inches. Weight is 0.92 pound.

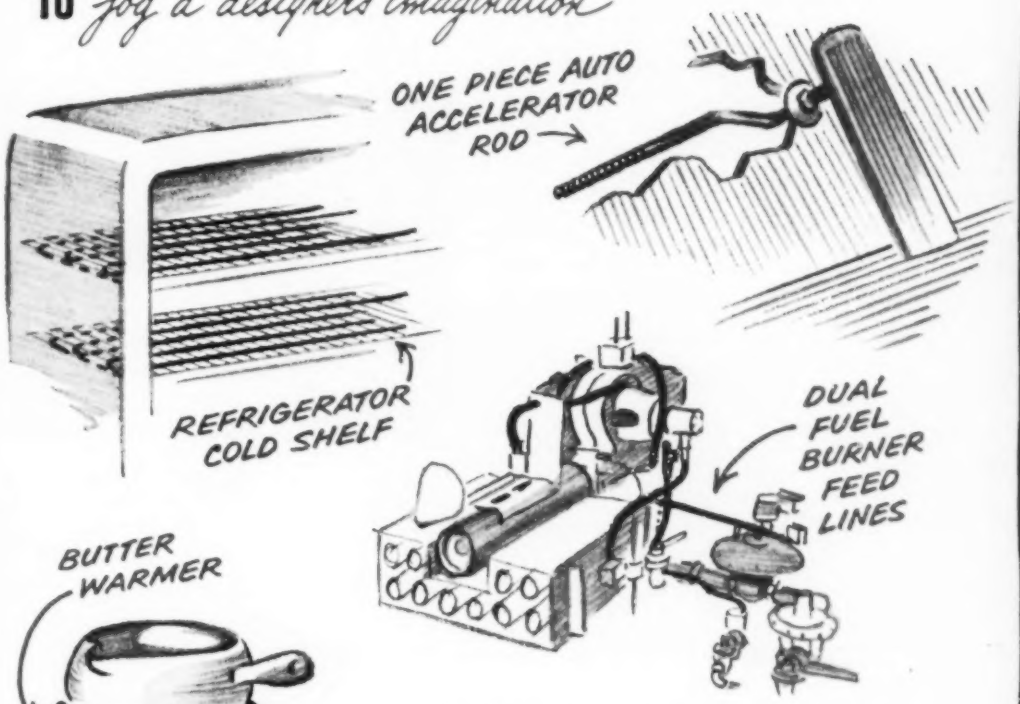
The relay is terminal and contact barriered construction for arc resistance. It has an all metal base, and is moisture and dust resisting. It is approved as AN-3339-1 per Spec MIL-R-6742 for electrical aircraft systems.



Leach Relay Company, 5915 Avalon Blvd., Los Angeles 3, Calif.

CONTINUED ON PAGE 240

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*



REMARKS Give your ideas a cost-saving twist -- with Bundyweld Tubing. The very standard of dependability, it's helped beat many design, fabrication problems. Add: Bundy's unmatched fabricating, specialized engineering.

WRITE today for Bundyweld catalog or for help in developing your tubing application ideas.

BUNDY TUBING COMPANY, DETROIT 14, MICH.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

Spring Tensions Easily Checked

Spring tensions, or the resistive force of any device that opposes motion, can be checked accurately and easily in the wide range from 4 to 2,500 grams, by means of a new line of small tension gages like the one shown in the illustration.

Only one hand is needed in applying the gage. The gage is preset to the required tension by a knurled micrometer screw. The end of the gage operating strip is then applied to the point at which the opposing force is to be checked, such as the tip of a spring. Deflection of the operating strip, at the same time that the resisting element moves, indicates that the opposing force is equal to the gage setting. Attention is concentrated on one point only—the movement at the point of contact.

The gages are precision calibrated, with adjustable zero correction. Knife-edge bearings have negligible friction, and gravitational effects are counterbalanced. Six models are available to cover the following ranges in grams: 4 to 24; 10 to 80; 50 to 250; 100 to 500; 200 to 1,600; and 500 to 2,500. In the three lighter gages, interchangeable operating strips are provided to suit the type and position of the spring or other mechanism under test.

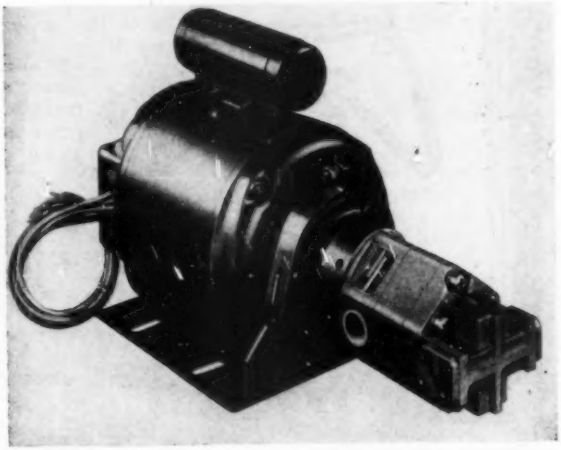
IMTRA Corp., 58 Charles St., Cambridge, Mass.

Hydraulic Pumps with Integral Motor Drives

Hydraulic pumps of the LA and LB series, with integral electric motor drives for low capacity, low pressure applications may be adapted to pressure lubrication systems, oil circulating systems, oil filtering systems, lift systems, oil transfer and replenishing systems, low pressure hydraulic systems and other uses. Design permits use not only with oils, but with other liquids having a substantial oil base.

Capacities range from 0.25 gpm to 4.5 gpm at 100 psi. Maximum working pressures may be increased to 200 psi with power requirements not to exceed ½ horsepower. Internal relief valves make it possible to vary relief pressures between 50 and 200 psi with a simple adjustment.

Because these motor driven pumps are independently powered, they may be installed at the most convenient location in a system. A wide selection of porting arrangements simplifies plumbing. Motor and pump are combined on one standard motor base to reduce installation time.

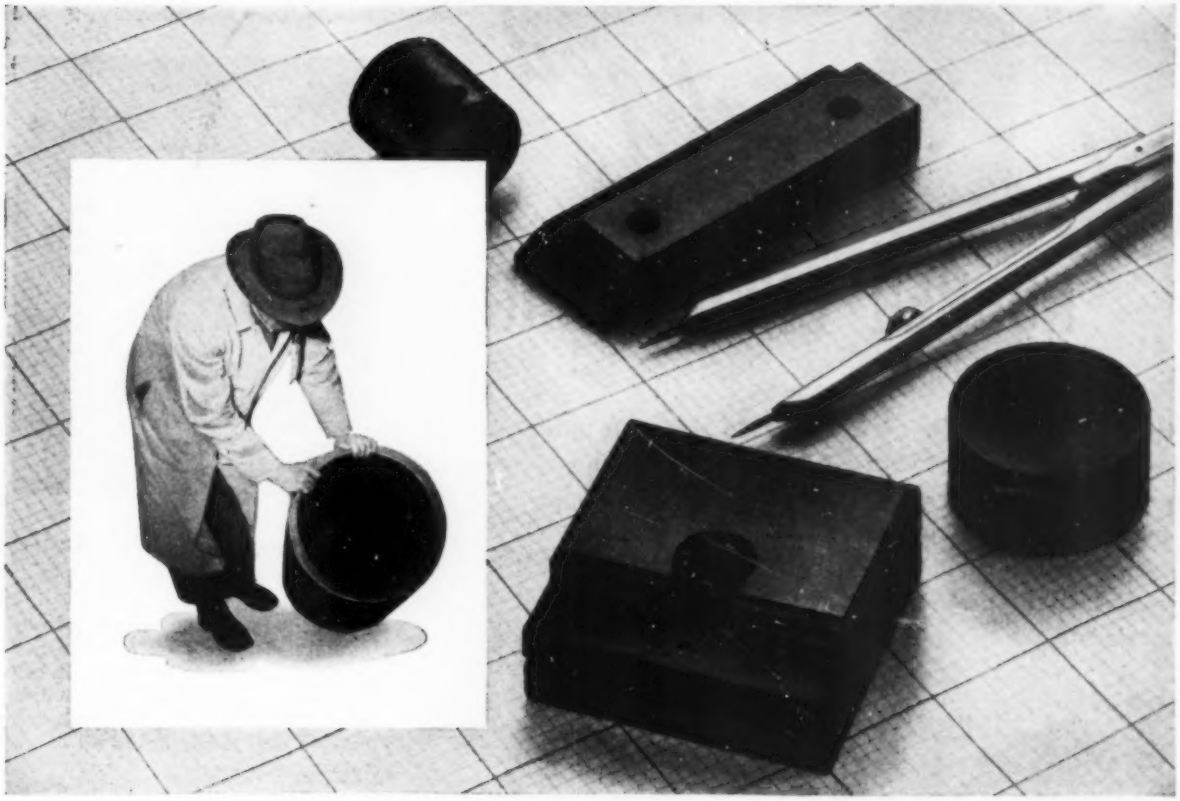


Webster Electric Co., 1900 Clark St., Racine, Wis.

A NEW MOTOR DESIGN is the reason for a line of 1/30 to ¼ hp, two-pole shaded pole motors which are approximately half the size and half the weight of normal two-pole motors of equal power rating. The new design, in which the shaft is centered rather than offset, produces a motor of 1/10 hp which measures about 2¼ x 4¼ x 2¼ in., and weighs about four pounds. Because of its high efficiency, the new motor can be used in geared-down and pulleyed-down applications. Motors of other horsepower ratings are available, proportionately light in weight. Burgess Vibrocrafters, Inc., 180 North Wabash Avenue, Chicago, Ill.

A SERIES OF IMPROVED multi-element aircraft instruments consists of single seal glass-to-metal hermetically sealed aircraft types of the ruggedized D'Arsonval movements, and a special columnar construction which is said to provide greater rigidity and more precise alignment of the elements. Available as two element (model AN32E), three element (model AN33E), and four element (model AN34E) types, applications include: ammeters, voltmeters, radio navigational types, temperature indicators and others. The instruments meet AND 10401 dimensional requirements for 2¾ in. dial instruments. Marion Electrical Instrument Co., Manchester, N. H.

CONTINUED ON PAGE 242



Here's how CARBONEERING by Speer helps solve design and materials problems

***You be the judge of carbon's versatility**

Carbon can be:	Carbon has:
Sawed	High corrosion resistance
Drilled	High heat transfer
Milled	Low electrical resistance
Broached	High thermal shock resistance
Turned	High heat transfer (graphite)
Planed	**Carbon is:**
Hobbed	Non-warping
Ground	Not wetted by molten metals
Molded	Chemically inert
Extruded	Self-lubricating (graphite)

SPEER Carbon Co.

St. Marys, Pa.

Divisions: Speer Resistor • Jeffers Electronics
International Graphite & Electrode

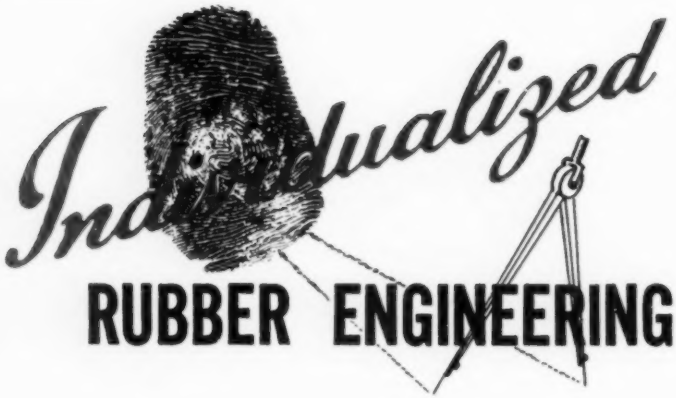
Short of the "right" materials?

Many a design engineer has revised his notions of materials requirements after seeing some of the results of Speer *carboneering*—the design and manufacture of parts and equipment from carbon and graphite. Carbon products are versatile*—can frequently perform better than the materials they replace.

Speer has been *carboneering* new parts and designs for over fifty years. This large graphite crucible—for example. It was designed and made by Speer specifically for a firm that manufactures carbide-tipped tools. It has the high heat transfer and resistance to thermal shock necessary for a crucible material. It is not wetted by molten metals and it is relatively inexpensive.

Or consider these contacts—in wide use as circuit breakers and motor starting devices. The carbon grades used give them high mechanical strength to withstand heavy service. These contacts are dense in structure and will not burn away under severest arcing conditions.

Speer's experienced designers and engineers can make carbon perform many new and unusual tasks. If you have a design problem—or are hobbled by materials difficulties – why not let Speer help you *carboneer* a practical solution? Send us all the details.

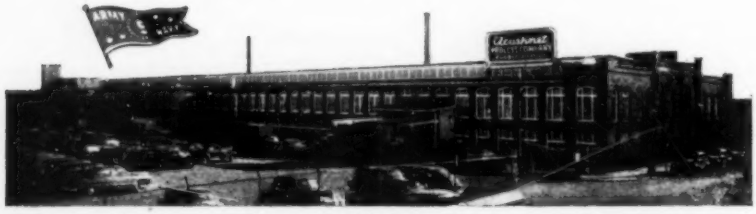


Here at ACUSHNET we are completely staffed to give individual engineering service on each individual order, through each stage of production. As we do not make or stock standard items, our entire facilities and specialized knowledge are concentrated on the development and production of precision-molded rubber

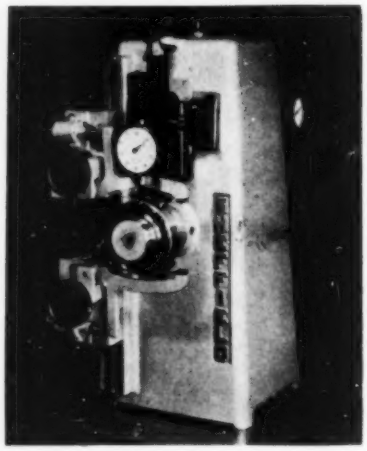
parts to individual specifications. Molds are skillfully designed for the most economical production, and all stocks individually compounded with properties to overcome specific conditions. When "precision" in rubber molded parts is a "must", you can depend completely on our engineering ability to meet your strictest requirements.

Acushnet
PROCESS COMPANY

Send for your copy of the "Acushnet Rubber Handbook", a comprehensive rubber data reference for molded rubber parts.



Address all communications to 768 Belleville Ave., New Bedford, Mass.



Fast Measurement of Radial Play in Ball Bearings

Easier, faster, and more accurate measuring of the radial play in ball bearings is said to be possible with this internal clearance measuring instrument that can be used on a production basis as well as the inspection of incoming shipments.

One standard model is used for bearings with an outer diameter of 18 mm to and including 90 mm, and another will handle an outer diameter from 90 mm to and including 180 mm.

The instrument features two easily adjustable, air-operated pivotal load bearing arms, that alternately exert upward and downward pressure on the bearing. At the same time, it measures the successive movements of the outer ring to determine the amount of radial play of the bearing in that position.

Other features include: an automatic shakedown of the balls into the bottom of the groove; direct readings without use of masters; and a single three-station foot pedal control of load bearing arms.

The Sheffield Corp., Dayton 1, Ohio

Clamp Seal for Pipe Leaks

The Bel connector, a cast-iron fitting, seals pipe leaks quickly, without cutting off flow in the system. The connector is made in two parts joined by four screws and is designed to enclose the leak within neoprene gaskets when the screws are tightened around the pipe. The sealing gaskets form a gas-tight chamber which equalizes pressures inside the pipe and out. The fitting itself exerts no pressure on the leak or the weakened area around it,

It's welded... but you can't feel the weld

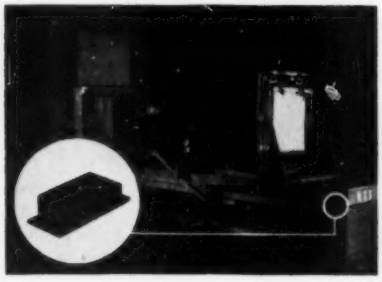
• A special tool removes any exterior weld flash from electric-welded steel tubing immediately after welding . . . thus the *eye-appeal* of products like tubular steel furniture. If required, the inside can be similarly finished, meeting the *functional* requirements of products like pneumatic tube systems.

Investigate the economy and physical advantages of Brainard welded steel tubing for *your* products. Write Brainard Steel Division, Dpt. GG-10, Griswold Street, Warren, Ohio. An integrated producer; offices throughout the U. S.

Brainard
SHARONSTEEL
STEEL DIVISION
SHARON STEEL CORPORATION

WELDED STEEL TUBING

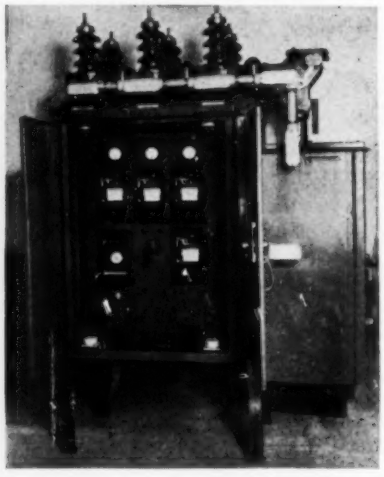
SHOCK – VIBRATION – NOISE
ISOLATION NOTES



A PHOTO-ENGRAVER'S CAMERA "floated" on Barrymounts, is isolated from floor vibrations. Result: sharper images and faster operation.

MEET DEMANDS OF MILITARY SERVICE Barry unit vibration isolators and mounting bases protect delicate electronic equipment in military aircraft and in guided missiles.

GRINDER ACCURACY PROTECTED Barrymounts, used to isolate grinders from building-borne vibration, eliminate chatter marks. Result: higher output and better finish.



INSTRUMENT AND CONTROL PANELS mounted on Barry isolators, are unaffected by vibration from nearby heavy machinery. Result: sensitive adjustments "stay put," and frequent recalibrations are avoided.

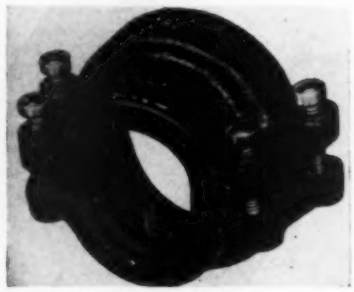
IN ANY FIELD OF MILITARY OR INDUSTRIAL INTEREST the wide range of Barry products, and the experience of Barry engineers, can help you solve shock, vibration, and noise problems. Call our nearby sales representative, or write directly to us.

THE BARRY CORP.

730 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington



eliminating the risk of collapse or enlargement of the defect.

It has been maintained in constant service on high-pressure steam systems for over 2 years without failure, and has tested safe at pressures up to 150 psi.

There are two types of connectors: the Elbow Bel for repairing pipe to elbow or T joints; and the Straight Bel for leaks in a straight section. Both are available in a variety of sizes to fit most standard pipe.

Holoal Mfg. Corp., P. O. Box 95, Bellerose 26, N. Y.

Portable Industrial X-Ray Unit

A portable industrial X-ray unit that fits into the trunk of an automobile has been designed specifically for the rapid inspection of welds, pipe lines, power plant, ship and aircraft equipment. The new unit is unique in that the X-ray tube head also contains the high tension generator of 150,000 v output. It weighs 143 lb, with the accompanying control weighing 80 pounds. The complete MG 160 equipment weighs 223 pounds.

The arrangement of tube and generator in one housing eliminates the need for high tension cables. The X-ray tube is fan-cooled and has an end port which provides maximum usefulness in handling various types of close-inwork. The combination tube and generator unit has a diameter of

10⅝ in., and is 35 in. long. Where desired, the diameter can be reduced to 8½ in. by eliminating the removable guards.

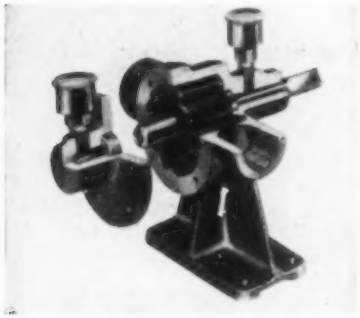
Power supply for the MG 160 unit can be either 115 or 230 v a-c. Current drain is 20 amperes.

North American Philips Co., Inc.
750 South Fulton Ave., Mount Vernon, N.Y.

New Impeller Design Increases Pump Output

Use of a new impeller design, having 12 vanes instead of 6, has resulted in a high pump output, and improved priming qualities, while reducing impeller drag and increasing mechanical efficiency.

With the impellers molded of heavy



duty rubber having sharp lateral wiping edges, it will handle dirty water, kerosene, and fuel oil without clogging.

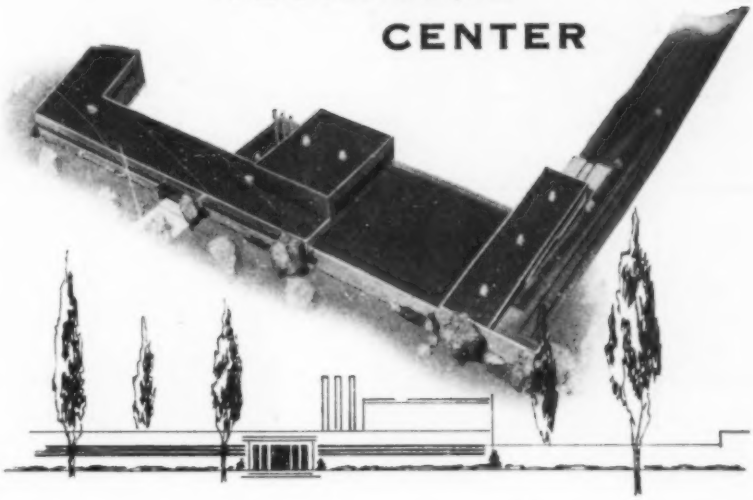
Three models are available in ½, ¾, and 1 in. port sizes. The pump case is rust-proof bronze.

Hypro Engineering, Inc.,
404 N. Washington Ave.,
Minneapolis, Minn.

Large Volume Air Regulator

An air regulator, capable of handling a large volume of compressed air with a minimum of pressure drop, has a capacity of 80 cfm at 100 pounds

NATIONAL
TECHNICAL
CENTER



Building for your future...

Newest physical testing machinery . . . latest electronic test devices . . . a new building designed for their efficient use . . . railroad car impact test tracks—that's the *new* National Technical Center where tests and research on castings will be carried out.

The Technical Center's facilities are available to you manufacturers and railroaders who seek new facts and data on the strength and weakness of castings used in your products.

We invite your inquiry for discussion of possible assistance the National Technical Center can give you. Write for descriptive bulletin on test facilities and equipment.

NATIONAL
MALLEABLE AND STEEL
CASTINGS

85TH ANNIVERSARY
M&S Co.
1868 ... 1953

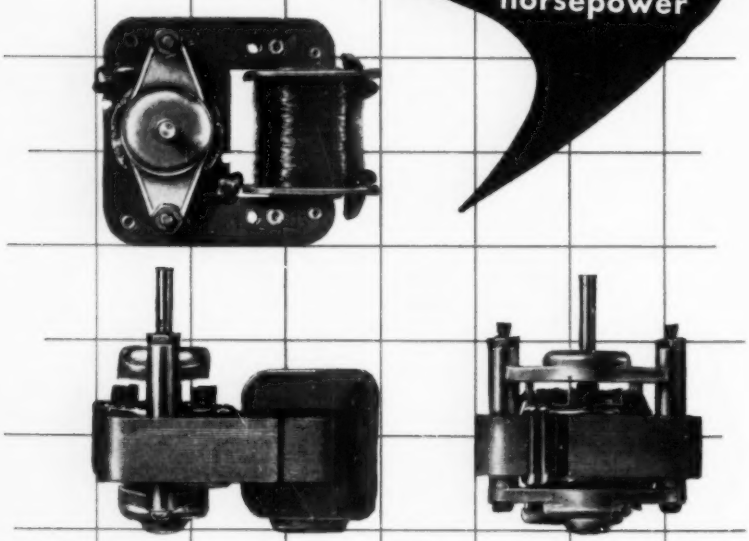
COMPANY
Cleveland 6, Ohio

A-5285

Bathroom heaters
Sound recorders
Phonographs
Record changers
Kitchen exhaust fans
Small unit heaters
Timing devices
Window ventilators
Business machines

Air pulsators
Furnace controls
Vending machines
Blowers

wherever you require 1/50th to 1/500th horsepower



SPECIFY

Smooth Power small motors

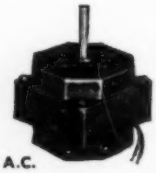
Full-rated power packed into a compact package . . . long-life dependability at mass-production cost . . . General Industries' *Smooth Power* Small Motors combine all the features you require to power practically any application requiring 1/50th to 1/500th H.P.

The four types illustrated permit you to fit *Smooth Power* Motors into your present production or future designs. Write for design data and specifications.

. . . also these models

Model C—
2-pole A.C.
induction
type

Model O
2-pole reversible
capacitor type
(for 6 or 12 or
24 volt A.C. only)



Model D 4-pole A.C.
induction type

50th ANNIVERSARY
1903 . . . 1953

The GENERAL INDUSTRIES Co.
DEPARTMENT MM • ELYRIA, OHIO

line pressure. It is manufactured in two models, each basically the same with the exception of inlet and outlet connection arrangements.

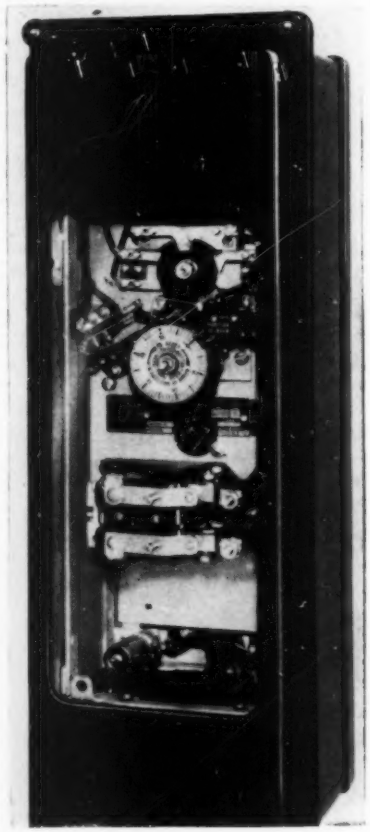
More sensitive control and reduced pressure losses have been made possible by using air pressure against the regulating diaphragm instead of the conventional spring-loaded diaphragm The device provides power regulation, which makes adjustment of the control knob easier when regulating air pressure. Air flow increases as demand increases without affecting the pressure which has been set.

The maximum pressure which can be regulated is 135 psi and the maximum line pressure has been set at 300 psi. The new unit is about 3 in. wide and 4½ in. high.

The DeVilbiss Co., 300 Phillips Ave., Toledo 1, Ohio

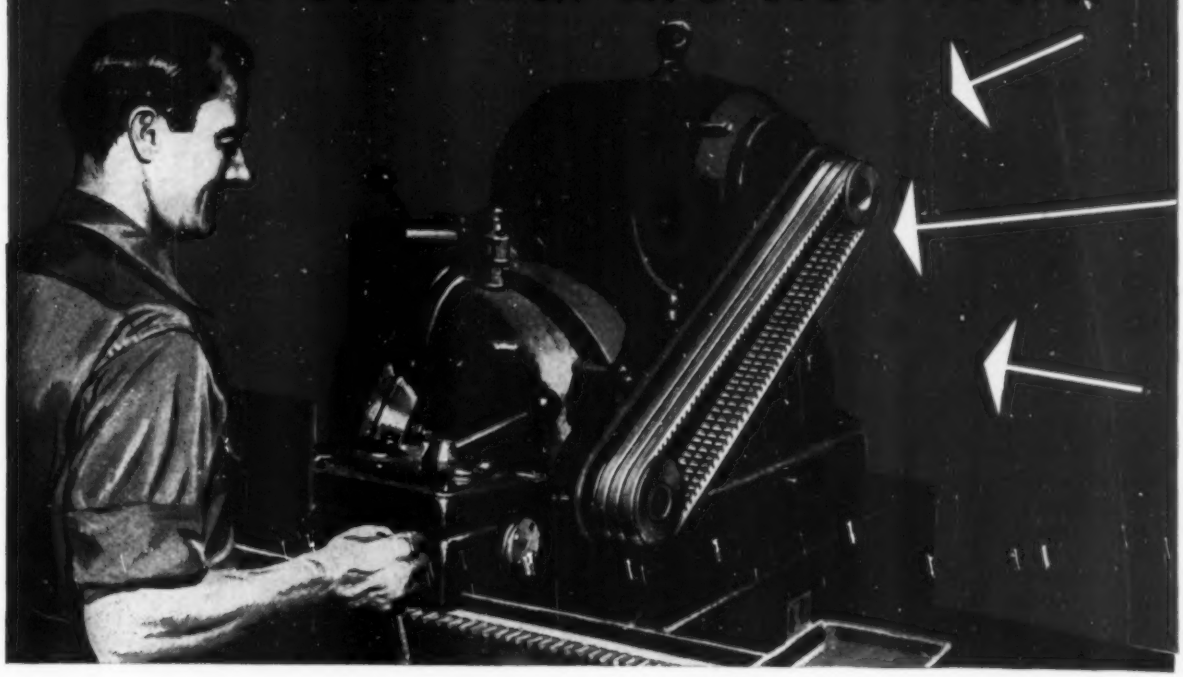
Automatic Reclosing Relay With Instantaneous Trip Lockout

An automatic reclosing relay (RC) with a built-in instantaneous trip lockout feature has been designed primarily to automatically control the reclosing operation of a circuit breaker.



Dayton Cog-Belts*

Eliminated Vibration and Increased Belt Life 4160 hours!



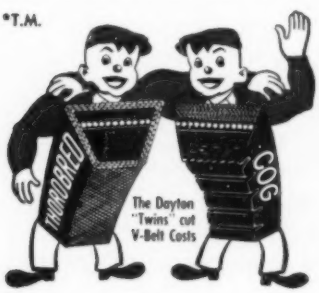
THE PROBLEM: Elimination of vibration on the grinders used to grind threads on jet engine parts. This vibration destroyed the accuracy of these vital threads.

ATTEMPTED SOLUTION: Conventional V-Belts eliminated the vibration difficulty, but belt life was only 1100 hours.

REAL SOLUTION: Dayton Cog-Belts were installed. *On the same machines,* under the same conditions, Cog-Belts ran 5260 hours—nearly five times as long! Performance like that is routine for Dayton Cog-Belts. Their greater flexibility makes them ideal for use over small pulleys. Their stronger *grip* transmits up to 40% more horsepower—lets you save weight and space on drives. Write for all the FACTS about Dayton's complete line of V-Belts, including the famous, exclusive Cog-Belt. Dayton's engineering staff is ready to help you with any drive problem. No obligation, of course. Just write, wire, or phone.

DAYTON RUBBER COMPANY • DAYTON 1, OHIO

*T.M.



Dayton Rubber

Since 1905

WORLD'S LARGEST MANUFACTURER OF V-BELTS

©D.R. 1953

You benefit 4 ways when you insist on this mark

ONLY CURTIS OFFERS ALL FOUR

1. ***Availability*** — 14 sizes always in stock; ⅜" to 4" O.D., bored or unbored hubs.

2. ***Quality Standards*** — Curtis Joints set the standards for the industry; *uniform* high quality provides complete protection.

3. ***Simplicity*** — fewer parts, simpler construction, easy assembly and disassembly.

4. ***Constant Tests*** — catalog figures substantiated by constant tests on production joints in the factory for torque, tension and compression.

PLUS — facilities and engineering skill to handle special specification jobs always available.

Not sold through distributors: write direct for free engineering data and price list.

CURTIS

TRADE MARK

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE
SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

The RC will prevent repetitive tripping due to the action of the instantaneous trip of the protective relay. This feature is desirable where feeders are sectionalized by fuse operation, since the closed circuit breaker will then allow the fuse to clear the faulted feeder.

External terminals provide connection to internal coils and contacts to permit its application to all types of circuit breaker control schemes. Adjustable reclosing time sequences of 60, 90, 180, or 360-seconds are provided by a 600 rpm synchronous motor with a gear train of adjustable ratio.

The relay may also be obtained with an adjustable integrating lockout device which limits successive circuit breaker reclosures to a safe value.

Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Radial Bearings Have Labyrinth Seal

Series 7,500 and 7,600 precision radial bearings, are single row, solid race type with ball retainer, and have an efficient labyrinth seal to retain lubricant and exclude foreign materials. These bearings are designed for medium loads and speeds in the neighborhood of 5,000 rpm maximum.

Both series 7,500 (no extensions) and series 7,600 (extended inner race with two locking set screws, shown in illustration) can be provided with or without snap ring. Normally double sealed, series 7,500 and 7,600 bearings can be produced with seals on one side only, or without seals.

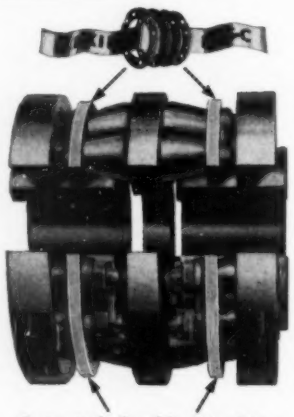
Nice Ball Bearing Co., 2925 Hunting Park Ave., Philadelphia 40, Pa.

Safety Shut-Off Valves

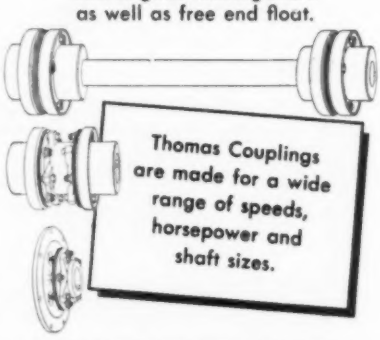
Of the normally closed form, these model 8020 safety shut-off valves, are arranged so that they can be opened manually, and will be held open only

Specify **THOMAS** ALL METAL **FLEXIBLE COUPLINGS for Power Transmission to avoid Costly Shut-Downs**

DISTINCTIVE ADVANTAGES	
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



Thomas Couplings are made for a wide range of speeds, horsepower and shaft sizes.

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

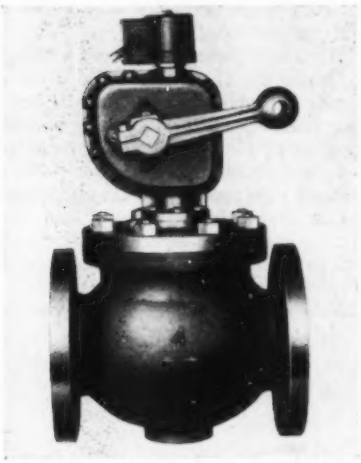
NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

THOMAS FLEXIBLE COUPLING CO.

WARREN, PENNSYLVANIA, U.S.A.



while the release solenoid is energized.

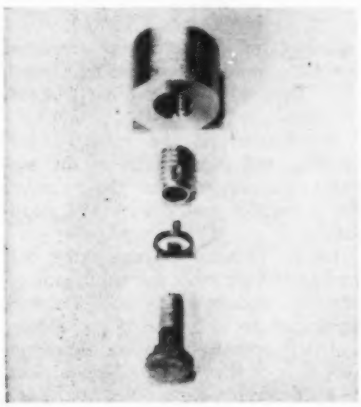
The operating mechanism is assembled in a cast iron pressure tight enclosure with solenoid on top, and an external lever, arranged to operate the mechanism by means of a rotary shaft passing through a tightly packed stuffing box. Any amount of friction in this stuffing box cannot prevent or retard the valve from closing whenever the solenoid is de-energized, because the valve stem is positively disconnected from the shaft when this action occurs.

Valve bodies are globe type full pipe with renewable tight seating composition disks. Sizes are from ½ in. to 6 in. IPS; maximum pressure is 150 psi.

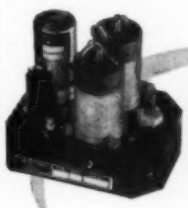
Davis Automatic Controls Ltd.,
4251 Dundas St. West,
Toronto, Ontario, Canada

Positive Locking Inserts and Studs

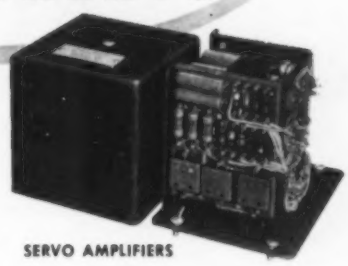
A simplified locking system for threaded fasteners such as inserts and studs is accomplished with a simple ring key which makes it easy to install



PRECISION
Servo Systems
AND COMPONENTS



MOTOR-DRIVEN INDUCTION GENERATOR, GEAR TRAIN & SYNCHRO COMBINATIONS



SERVO AMPLIFIERS

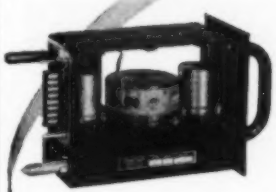
MOTOR-DRIVEN INDUCTION GENERATORS

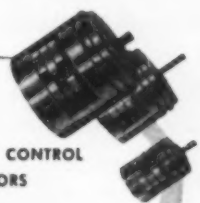
PLUG-IN ASSEMBLIES OF CONTROL MOTOR, GEAR TRAIN, POTENTIOMETER & SYNCHRO

Transicoil servo systems feature integrated design—every component is made to match all the others . . . coordinated to insure maximum efficiency and top performance.

For systems of your own design, Transicoil can supply precision components designed to meet your requirements . . . their effectiveness limited only by the restrictions you impose.

Complete data will be sent on request.





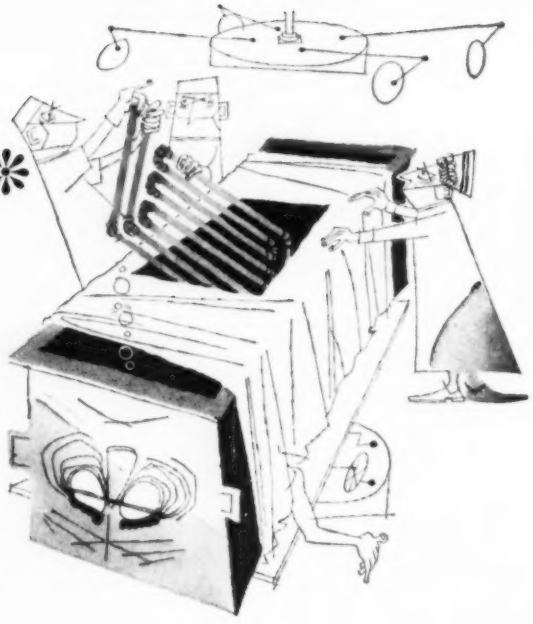
MINIATURE CONTROL MOTORS

TRANSICOIL
CORPORATION 107 Grand Street New York 13, N. Y.

Engineering-Sales Representatives in:

Boston, Mass. • Buffalo, N. Y. • Chicago, Ill. • Cleveland, Ohio • Dallas, Tex.
Kansas City, Mo. • Los Angeles, Calif. • Minneapolis, Minn. • Netcong, N. J.
Philadelphia, Pa. • Phoenix, Ariz. • San Francisco, Calif. • Seattle, Wash.
Syracuse, N. Y. • Washington, D. C.

has
coil-itis ✻
got you
constantly
doctoring
your
tanks?



Like the human appendix, pipe coils often give constant trouble until they are removed and replaced with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster. They take 50% less space in the tank leaving room for greater payload. Platecoils overcome the limitations and operating difficulties of old fashioned and outmoded pipe coils to save hours of downtime.

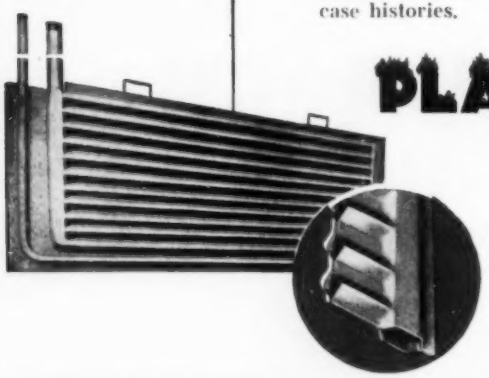
It costs less to cure coil-itis with Platecoils than to suffer its evils.

Write for Bulletin P77 today!

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS REQUIRE 90% LESS CLEANING

At Motor Wheel Corporation cleaning time has been cut from 10 hours per pipe coil every 60 days to only one hour per Platecoil. Ask about other case histories.



PLATECOIL

REPLACES PIPE COILS

✻

Coil-itis — Diagnosed as tank heating and cooling problems. Platecoils — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, TRANTER MANUFACTURING, inc., LANSING 4, MICHIGAN

or remove the insert or stud without the use of special tools.

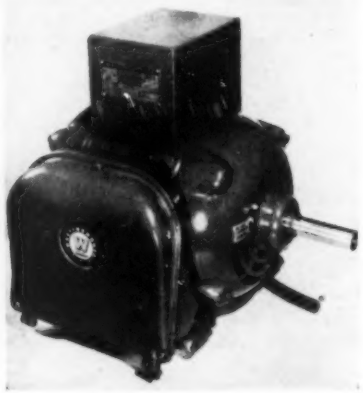
This new method of thread locking is made up of a ring with smooth inside and outside diameters. Extending from the bottom surface of the ring are two keys. The keys mate with a keyway in the insert or stud. When pressed into position, the keys, guided by the keyway in the insert or stud, cut their way through sufficient threads of the parent body tapped hole to make a positive key-to-keyway lock between the two threated bodies (the parent body and the insert or stud).

Fasteners Inc., 1 West 47th St., New York 36, N. Y.

Capacitor-Start, Single-Phase Motor

Single-phase motors that are both capacitor-start and capacitor run are available in 5-, 7½-, and 10-hp ratings, and are a 4 pole, 220 volt, 60 cycle units.

These capacitor-run motors operate efficiently at near-unity power factor, and their design is such that starting current is reduced about 25 percent, with the same high starting torque. The auxiliary winding remains in the circuit during operation, and is in series with the running capacitors. Relays remove the starting capacitors when the motor approaches full speed. The main winding is directly across the line.



Elimination of the wound rotor, brushes, and commutator of the previous repulsion-induction design makes for a simpler motor with less maintenance.

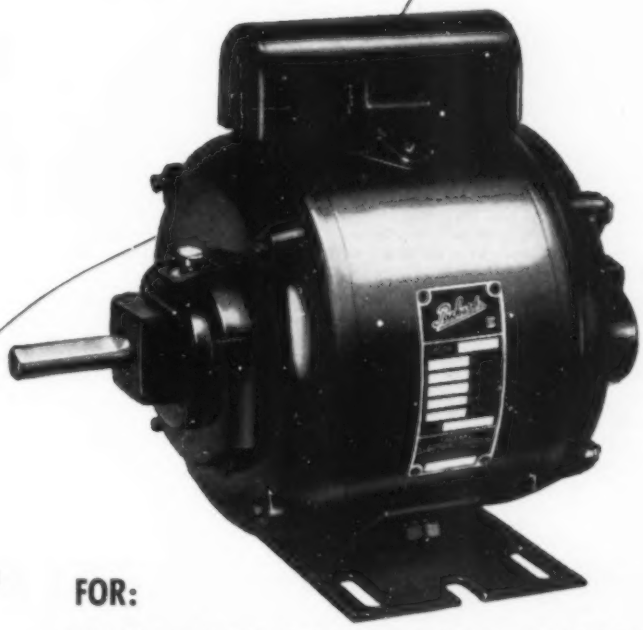
Other features: dynamically balanced, die-cast rotor for minimum vibration; double-width ball bearings lubricated for the life of the motor; and bell openings prevent dripping.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

GET THE FACTS... see why

more and more appliance makers choose

PACKARD ELECTRIC MOTORS



The makers of motor-powered products gain in *three ways* when they choose Packard Electric motors specially adapted for use with their products.

First: Manufacturers get the *right* motors for *their* products . . . motors that fit the space, provide correct starting and operating torques, and have the proper construction for long service.

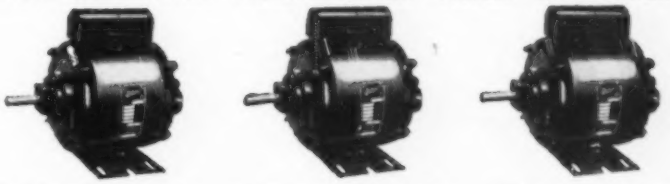
Second: Packard Electric motors are so dependable they help keep customers satisfied, help reduce complaints and servicing, and actually help increase product sales.

Third: Manufacturers get these specially engineered motors at low cost . . . due to Packard Electric's tremendous facilities for volume production.

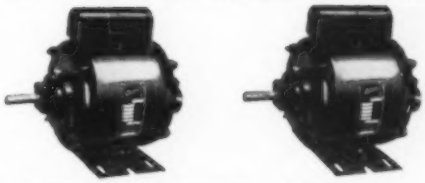
So, if you have any motor problem, call on Packard Electric. Let Packard's engineers show you how you can gain with Packard Electric motors.

FOR:

DISPOSAL UNITS • DRYERS • IRONERS • WASHERS • STOKERS • LAWN MOWERS



VENTILATING UNITS • MILKING MACHINES • CREAM SEPARATORS



BLOWERS • OIL BURNERS • COMPRESSORS • WATER PUMPS • BENCH TOOLS

DEPENDABLE APPLIANCE MOTORS FOR THIRTY-SIX YEARS

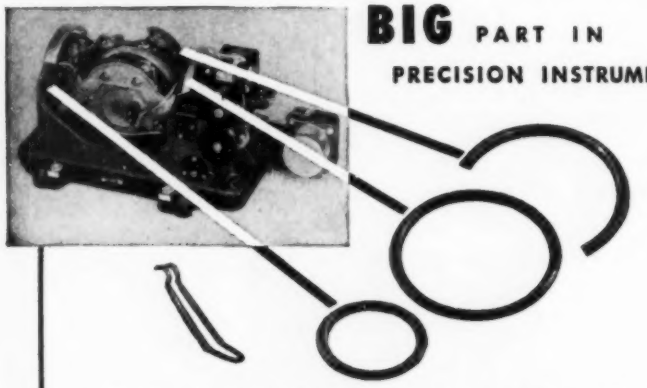
GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors Corporation
Warren, Ohio

NEY'S SMALL PARTS PLAY A **BIG** PART IN PRECISION INSTRUMENTS



This Cageable Vertical Gyro, for use in stabilization and control systems of aircraft, guided missiles and radar scanners, manufactured by the Aeronautical Division of the Minneapolis-Honeywell Regulator Co., contains three doughnut potentiometers wound with NEY-ORO G high strength, precious metal resistance wire, contacted with wiper brushes of Paliney #7* (illustrated at far left).

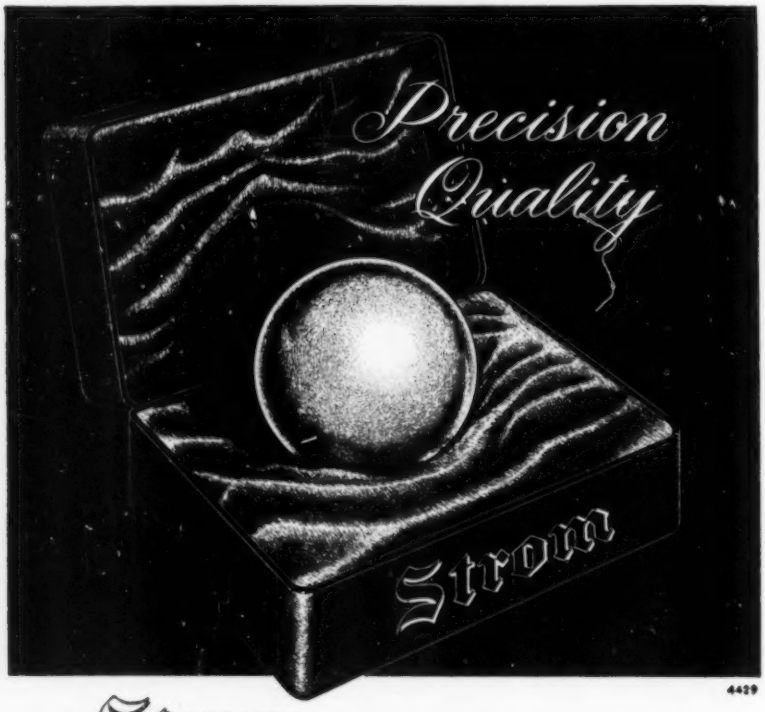
Many other manufacturers of precision instruments specify Ney precious metal component parts for use as slip rings, brushes, wipers, commutator segments, etc. Ney Precious Metal Alloys have specific qualities which mean greater accuracy, longer life and resistance to most corrosive industrial atmospheres.

Call or write the Ney Engineering Department for assistance with your instrument problems.

*Registered trade mark

THE J. M. NEY COMPANY • 109 Elm Street, Hartford 1, Conn.
Specialists in Precious Metal Metallurgy Since 1812

LSNY838



4429

Strom STEEL BALL CO.
Largest Independent and Exclusive Metal Ball Manufacturer
1850 SO. 54th AVE., CICERO 50, ILLINOIS

MEETINGS

October 14-16

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Annual Machine Tool Conference, Cleveland Hotel, Cleveland, Ohio.

October 16-18

SOCIETY OF INDUSTRIAL DESIGNERS—Annual Design Conference, Bedford Springs Hotel, Bedford, Pa.

October 19-23

NATIONAL METAL EXPOSITION—Public Auditorium and Lakeside Exhibition Hall, Cleveland, O.

October 23-24

NATIONAL NOISE ABATEMENT SYMPOSIUM—Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

October 25-28

AMERICAN GEAR MANUFACTURERS ASSOCIATION—Semi-Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

October 26-30

NATIONAL PAINT, VARNISH AND LACQUER ASSOCIATION—Annual Convention and Paint Industries Show, Chalfonte-Haddon Hall, Atlantic City.

October 28-30

AMERICAN SOCIETY OF BODY ENGINEERS—Annual Technical Convention, Rackham Memorial Building, Detroit, Mich.

October 29-30

SOCIETY OF AUTOMOTIVE ENGINEERS — International Production Meeting, Royal York Hotel, Toronto, Ontario, Canada.

October 29-30

SOCIETY FOR ADVANCEMENT OF MANAGEMENT—Annual Fall Conference, Hotel Statler, New York.

November 2-4

SOCIETY OF AUTOMOTIVE ENGINEERS — National Transportation Meeting, The Conrad Hilton, Chicago.

November 2-6

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS — Fall General Meeting, Muehlebach Hotel, Kansas City, Mo.

Catalogs and Bulletins

Request additional information using postcards following page 224

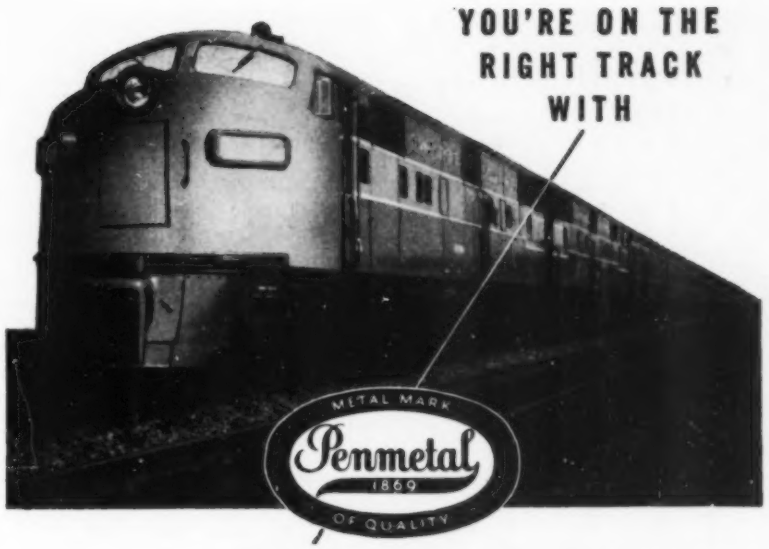
(1) PREALLOYED STEEL POWDER — Vanadium-Alloys Steel Co., Bulletin 3, 12 pp. Has the technology of prealloyed stainless steel powders, properties, production, uses. Illustrations show range of sizes; charts give properties and sintered properties of stainless steel powders; and curves of tensile strength.

(2) AUTOMATIC CONTROLS — Penn Electric Switch Co., Bulletin 1534-K, 20 pp. Illustrating and giving specifications for each type of control for pumps and air compressors, it covers: air volume controls for deep and shallow well; contactors; float controls for closed and open tank; flow controls; pressure controls; starters; unloaders; and vacuum controls.

(3) STAINLESS STEEL WIRE—Allegheny Ludlum Steel Corp., Booklet, 20 pp. Has technical data on the application of stainless steel wire. Has tables of physical properties, corrosion resistance, and analysis. Discussion of uses include: cold heading, weaving, heat resisting belts, rope, spring wire, slide forming, welding, and winding. Completely illustrated.

(4) FIBRE ELECTRICAL INSULATIONS—Insulation Mfrs. Corp., two catalogs, 40 pp. Helpful information on the features and uses of fibre and plastic for electrical insulation. Many illustrations and complete descriptions and tabular data on grades and properties of vulcanized fibre, fishpaper, laminated plastics, spirally wound tubing, and reinforced plastic rods and sheets.

(5) GEAR TOOTH DRIVE DISK CLUTCH—The Conway Clutch Co., Booklet, 20 pp. Has many illustrations, cross-section views, and com-



EXPANDED METAL MESH

Cheapest "Diamonds" You Can Buy

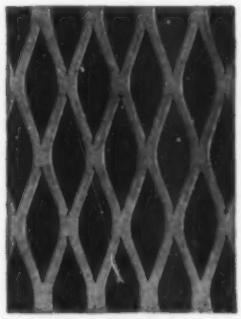
Farr Filter Adapter Assembly used extensively on freight and passenger locomotives.

1000's OF USES

Railroad Air Filters, for example: Penmetal Expanded Metal Mesh is strong, good-looking, light-weight, non-warping, fireproof. It is easily formed, shaped and welded . . . weighs as little as 10% of the solid sheet. That's why the Farr Company of Los Angeles uses Penmetal Expanded Metal Mesh in the design and construction of Far-Air Filters for Diesel Locomotives, Passenger Cars, Air Compressors and special railroad applications.

MAKES A LITTLE METAL GO A LONG WAY. Penmetal Expanded Metal Mesh is sheet metal — slit, then stretched up to 10X its original area. Resulting diamond truss pattern adds rigidity — permits free passage of heat, light, sight, sound and air. Available in corrosion-resistant metals and carbon steel. Large or small mesh, light or heavy gauge.

STANDARD EXPANDED METAL



FLATTENED EXPANDED METAL

Get the facts! They'll suggest 1000's of ideas and applications. Write for free Bulletin EM40.

PENN METAL COMPANY, INC.

GENERAL SALES OFFICES • 205 East 42nd Street, New York 17, N. Y.

BOSTON NEW YORK PHILADELPHIA WASHINGTON PARKERSBURG
DETROIT CHICAGO DALLAS LOS ANGELES SAN FRANCISCO SEATTLE

WITH STAR-KIMBLE BRAKEMOTORS

Stopping of a Star-Kimble Brakemotor is split-second in action, precisely timed by simple adjustments. Quiet, too — no lining screech. Low lining pressure, evenly distributed, assures long brake life. Brake is self-adjusting to compensate for lining wear — ruggedly built to withstand shock and vibration.

Braking force is spring applied, magnetically released. No linkages to cause lost motion or friction.

Starting of a Star-Kimble Brakemotor is smooth and free from drag. Small magnetic air gap assures quick brake release without high inrush current.

And Star-Kimble Brakemotors *maintain* this fast, smooth stop-start operation through millions of cycles with little or no maintenance attention. Brake and motor are *designed* together to *work* together as a single compact unit. One manufacturer, one responsibility — backed by years of experience. For details on construction, motor ratings and braking torques, write for Bulletin B-501-A.

Standard and special motors of all types, 1 to 600 hp; Marine motors ½ to 600 hp; generators and motor-generator sets, 1 to 500 kw.

STAR-KIMBLE
MOTOR DIVISION OF
KIMBLE PRINTING PRESS AND MFG. CO.
211 Bloomfield Avenue Bloomfield, New Jersey

plete data on a disk clutch with a gear tooth drive. Covers single and triple plate sleeve clutch gear tooth drive; couplings; ball bearing sleeve clutch, single and triple plate; shifter collars. Bores 1¼ to 4 in.

(6) INDUSTRIAL CONTROLS—Minneapolis-Honeywell Regulator Co., Catalog 8305, 80 pp. Describes and illustrates non-indicating electric, electronic and pneumatic controllers for temperature, pressure and humidity, also pneumatic and electric valves, switches and relays. Includes specifications, dimension drawings, and application data.

(7) EXTRUDED PLASTICS—Midwest Plastic Products Co., Booklet, 8 pp. Discusses the variety of sheets, tubes, and shapes possible to extrude sheet widths from ¾ in. to 38 in. and thicknesses from 0.010 to 0.080 inch, and tubes from ¼ to ¾ in. O. D. Large chart lists types of plastics available, and their uses and properties.

(8) METAL COVERED WOOD—Met-L-Wood Corp., Bulletin, 521, 16 pp. Shows how it is made; compares strength to other materials; illustrations of the different types of edges; hints on how to fabricate and install the wood; and illustrations of the various applications. Lists metals used; woods and other materials used; and weights of various gage panels.

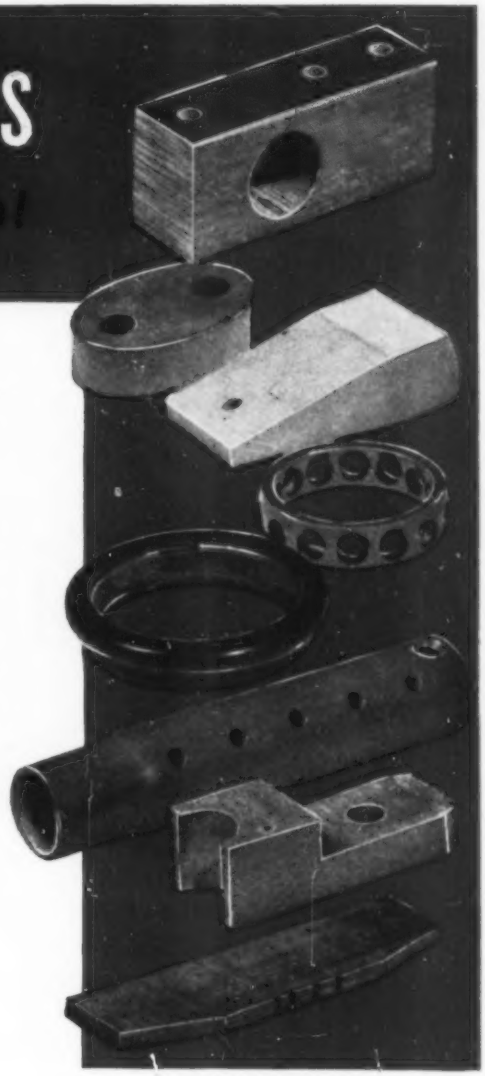
(9) MAGNETIC AMPLIFIERS—General Electric Co., Bulletin GEA-5950, 8 pp. Data on Amplistats (self-saturating magnetic amplifiers) for high-gain d-c amplification in control and instrumentation circuits. Explains theory of operation, defines terms, and shows characteristics with graphs and charts.

(10) MAGNETIC IRON POWDERS—Magnetic Powders, Inc. Catalog 354, 8 pp. Covers complete technical data, including photomicrographs, frequency vs. Q charts, and permeability rating graphs on uses and applications of annealed carbonyl iron powders, hydrogen reduced iron powders, and magnatites.

(11) CENTRIFUGAL PUMPS — Warren Steam Pump Co., Bulletin

LIGHTWEIGHTS

that do a HEAVYWEIGHT Job!



Spaulding products for industry weigh only one-half as much as aluminum. Yet they show excellent performance characteristics in tough applications in industrial machines.

The secret? These Spaulding products have extreme light weight ***in combination with*** structural strength, resistance to wear, dimensional stability, clean machining and quietness in mechanical operation.

Other types and grades of Spaulding products exhibit many different combinations of electrical, chemical and mechanical properties. Among them may be just the one you need to solve a difficult design problem, improve product performance or lower production costs.

Write or phone your nearest Spaulding Branch Office for full information.

Spaulding

SPAULDING FIBRE COMPANY, INC., TONAWANDA, N. Y.

MAKERS AND FABRICATORS OF:

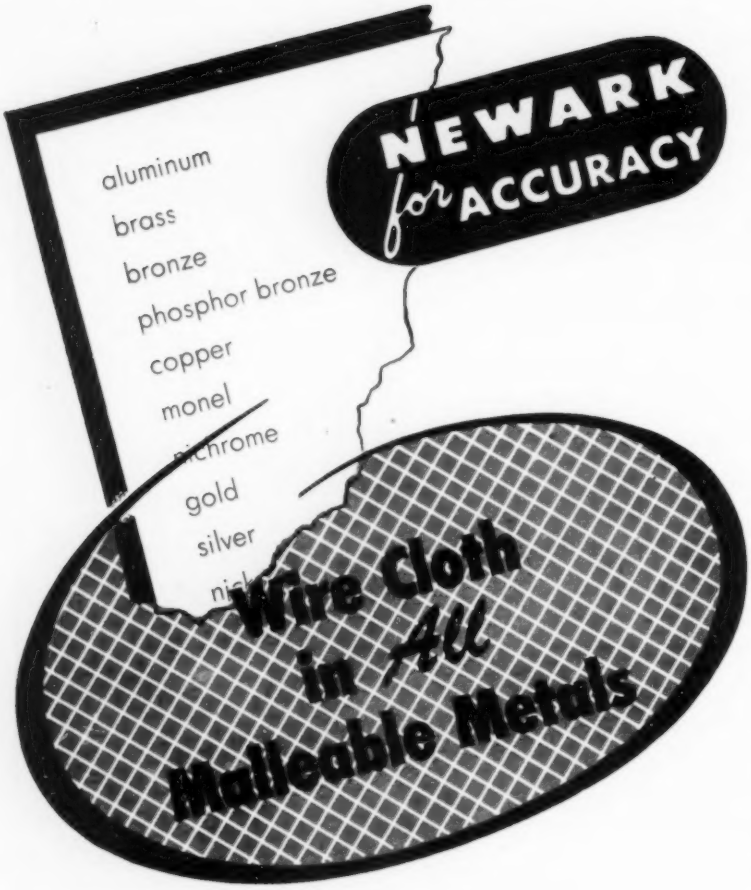
VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.
ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.
SPAULDITE: (Laminated Phenolic Plastic) in sheets, rods, tubes and fabricated parts.
SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.
SPAULDING FIBRE BOARD: In sheets and fabricated parts.
SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.
MATERIALS HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES

Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation to you.

SPAULDING BRANCH SALES OFFICES

BOSTON 16, MASS.
585 Boylston St.
BRIDGEPORT 5, CONN.
2889 Fairfield Ave.
CHICAGO 25, ILL.
4770 Lincoln Ave.
CHICAGO 38, ILL.
5604 West 63rd St.
CLEVELAND 14, OHIO
2108 Payne Ave.
CLEVELAND 16, OHIO
19035 Detroit Rd.
Rocky River
DAYTON 2, OHIO
136 South Ludlow St.
DETROIT 1, MICH.
4612 Woodward Ave.
FORT WAYNE 6, IND.
2301 Fairfield Ave.
LANSING 10, MICH.
2021 South Cedar St.
LONG ISLAND, N. Y.
90-34 Jamaica Ave.
Woodhaven 21, L. I., N. Y.
MILWAUKEE 8, WIS.
3329 West Vliet St.
NEW YORK 55, N. Y.
384 East 149th St.
NEWARK 2, N. J.
965 Broad St.
PHILADELPHIA, PA.
702 Federal St.
Camden 3, N. J.
ST. LOUIS 5, MO.
34 North Brentwood Blvd.
TONAWANDA, N. Y.
310 Wheeler St.
LOS ANGELES 5, CALIF.
C. D. LaMoree
1325 San Julian St.
BERKELEY 10, CALIF.
C. D. LaMoree
2221 Fourth St.
TORONTO 18, ONT., CANADA
A. A. Andersen & Co.
28 Jackson Ave.



Newark Wire Cloth is made of *all* malleable metals such as aluminum, brass, bronze, phosphor bronze, copper, monel, Nichrome, nickel and stainless steel; as well as the noble metals such as gold, silver, platinum, etc.

This wide range of metals enables you to select the one wire cloth to meet your conditions of corrosion and/or contamination.

In all metals, Newark Wire Cloth is accurately woven in a wide range of meshes, ranging from very coarse (4 inch space cloth), to extremely fine (up to 400 mesh). Our reputation for 'Accuracy' through more than 75 years is your guarantee of wire cloth quality.

We maintain a large stock of popular sizes in the more commonly used metals and can make prompt shipment. Let us quote on your requirements.

Send for our New Catalog E.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

WQ-214, 4 pp. Has complete data on a new addition to the type DF, end suction, centrifugal pump with capacities up to 1,000 gpm and heads to 400 feet. Features are double row thrust bearings, deep stuffing boxes, and renewable case wearing rings. Large cross-section view of pump included.

(12) SMALL TUBING—Precision Tube Co., Booklets, 12 pp. Covers a variety of small-size seamless metal tubing in O.D. sizes as small as 0.010 in. Has illustrations of preformed shapes available. Also contains mechanical and electrical specifications and general information on precision metal shielded wire.

(13) SCREW TYPE PUMPS—Sier-Bath Gear & Pump Co., Inc., Bulletin SE-5, 6 pp. Has engineering drawings, list of specifications, and a large two-page cross-section illustration of an external gear and bearing bracket type screw pump. May be used with non-lubricating fluids, and semi-fluids in the viscosity range of 32 to 1,000,000 SSU.

(14) FREE RUNNING LOCKNUT—Klincher Locknut Corp. Booklet, 4 pp. Colored illustrations show the locking operation of a locknut that can be reused many times. Made in various materials and will withstand temperatures up to 1,600 F without thread seizure. Thread sizes from 4-40 NC-3B up to 1-8 UNC-3B.

(15) INTEGRAL - HORSEPOWER MOTORS—Newman Industries, Inc. Catalog, 20 pp. Has specifications, illustrations and dimensions of a line of totally enclosed, fan cooled, squirrel cage motors up to 30 hp; and drip proof, wound rotor and squirrel cage motors up to 125 hp.

(16) MEASURING SURFACE ROUGHNESS — Micrometrical Mfg. Co., Bulletin LT 77, 8 pp. Gives the practical features and application of the Profilometer, a portable instrument for measuring the surface roughness of internal, external, straight, tapered, or circular surfaces. Many illustrations show instrument in use.

(17) SHAKER SYSTEMS — The Calidyne Co., Bulletins 6405 & 4805, 12 pp. Information on intermediate

INDUSTRY ASKED for it...HELPED US DEVELOP it...

AND **Here it is!**

THE NEW TYPE "RAC" ARROW AH HART COMBINATION STARTER

NEMA TYPES I, IA and XII

SIZE 2 NEMA XII

Features:

FOR NEMA XII

1. **HEAVY, SEAM WELDED CONSTRUCTION** . . . with no knockouts.
2. **OIL DRIP SHIELD** . . . prevents collected oil from dropping on starter when door is opened.
3. **EXTERNAL MOUNTING BRACKETS** . . . let oil drain down behind enclosure.
4. **OIL PROOF NEOPRENE GASKET** . . . retained by both cement and channel.
5. **AUTOMATIC LATCHES** . . . hold door securely even if locking screws are accidentally left loose.

FOR ALL-NEW DISCONNECT

6. **HEAVY SILVER CONTACTS** . . . for long life.
7. **CONTACTS COMPLETELY VISIBLE** . . . maintenance man can SEE that the Disconnect is off.
8. **CONTACT CARRIER INSTANTLY REMOVED** . . . for inspection or replacement.
9. **SIMPLE, SAFE, STURDY MECHANISM** . . . **COVER CAN'T BE OPENED WITH DISCONNECT ON** . . . handle must be turned to "Open" with Disconnect "Off".
10. **HANDLE PROVIDES FOR 3 LOCKS** . . . can only be locked in the "Off" position.

GENERAL

11. **ENTIRE COMBINATION REMOVABLE** . . . from box by merely loosening two non-removable screws.
12. **TRANSFORMER FUSED ON SECONDARY SIDE.**
13. **TYPE "RA" STARTER** . . . with exclusive "Right Angle" Operating Mechanism.
14. **ALL CONTROL WIRING *RED*** . . . **ALL LINE WIRING BLACK.**
15. **SMALLER SIZE** . . . **Size 1 unfused** . . . entire unit is just 15⅜" x 7½" x 4⅜".

ENGINEERED FOR SAFETY

NEMA TYPE XII built to JIC STANDARDS

TURN THE PAGE FOR ADDITIONAL INFORMATION

SIZE 2 NEMA XII

ENTIRELY NEW
OUTSTANDINGLY ADVANCED
EXACTLY RIGHT FOR INDUSTRY'S NEEDS

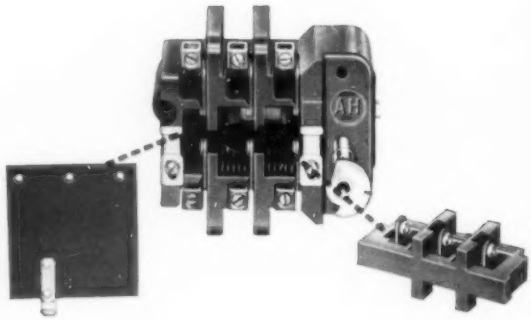
ARROW AH HART

TYPE "RAC" COMBINATION STARTER

Leading Machinery Engineers throughout industry worked with us to develop this all-new, "RAC" Across-the-Line Combination Starter. The NEMA Type XII is designed, engineered and constructed to meet all JIC Standards for Safety, Oil Tightness and Convenience in both operation and maintenance. In addition, the Type "RAC" offers smaller size plus new standards of electrical performance and dependability . . . possible only with the exclusive Arrow-Hart "RA" Starter Design.

Incorporating EXCLUSIVE "RA" DESIGN with All-New "RAD" DISCONNECT

The "RAD" Type Disconnect is a completely new, front operated design that offers many important advantages for both safety and convenience. The operating mechanism is simple and rugged with a safe "Off" position. The enclosure door of the "RAC" cannot be opened unless the operating handle is moved to the "Open" position and the Disconnect is off. The handle has provision for three padlocks and can be locked only in the "Off" position. The butt-to-butt type contacts of heavy silver are provided with a clip-on cover that may be used or not as desired. When this cover is removed, the contacts are completely visible for easy inspection . . . and to give the maintenance man an additional *visual* assurance that the Disconnect is off. The Contact Carrier . . . held in place by two swinging latches . . . can quickly and simply be removed entirely for fast, easy inspection, maintenance or replacement.



Available

- With GENERAL PURPOSE (NEMA TYPE I) ENCLOSURE
- With SEMI-DUST (NEMA TYPE IA) ENCLOSURE
- With OILTIGHT (NEMA TYPE XII) ENCLOSURE
- With DISCONNECT . . . Fused or Unfused Type
- With CIRCUIT BREAKER TYPE DISCONNECT
- REVERSING and TWO SPEED TYPES
- In NEMA SIZES 0, 1 and 2 . . . with Sizes 3 and 4 coming soon
- With or without CONTROL CIRCUIT TRANSFORMER

SEND NOW FOR COMPLETE INFORMATION ON THE TYPE "RAC" COMBINATION STARTER

AH

Industrial Control Division
THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 Hawthorn Street, Hartford 6, Conn.

Please send me complete product literature covering:
☐ *Type "RAC" Combination Starters* ☐ *"RA" Motor Control Design Story*

NAME_____
POSITION _____
COMPANY_____
CO. ADDRESS_____
CITY_____ ZONE_____ STATE_____

ARROW-HART
INDUSTRIAL CONTROL DIVISION
THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
HARTFORD 6, CONNECTICUT

OFFICES, SALES ENGINEERS AND WAREHOUSES IN: ATLANTA, BOSTON, BUFFALO, CHARLOTTE, CHICAGO, CINCINNATI, CLEVELAND, DALLAS, DETROIT, HOUSTON, INDIANAPOLIS, KANSAS CITY MO., LOS ANGELES, MILWAUKEE, MINNEAPOLIS, NEW YORK, PHILADELPHIA, PITTSBURGH, ST. LOUIS, SAN FRANCISCO, SYRACUSE. Sales Engineers in Columbus O., York, Pa., Fayetteville New York, Manchester Ct., Seattle, Springfield Mass. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO.

PRINTED IN U.S.A.

shaker systems of from 600 to 1,250 pounds force output; and on large systems with 2,500 pounds force output. Has engineering data and illustrations of the shakers, control units, power supplies, and accessories.

(18) WOUND ROTOR MOTORS—The Louis Allis Co., Bulletin 1300. Covers the wound rotor principles of operation, and contains performance curves and characteristics of the units in particular jobs. Outlines construction, methods of manufacture, and the various enclosures available.

(19) WOVEN WIRE CONVEYOR BELTS—The Cambridge Wire Cloth Co., Catalog, 132 pp. Has complete engineering data and illustrations on the many different types of mesh available in wire belts. Photos show application of conveyor belts in a variety of industries, with a sequence drawing given for each type of processing. Has hints on the choice of metal for the belt and the belt selection. Also has conveyor design hints, showing correct location of guides and supports, with line drawings showing many typical layouts.

(20) BALANCED PRESSURE SEAL—Sealol Corp., Bulletin 7, 8 pp. Describes a mechanical, or face type shaft seal for high pressure applications. Has a balance pressure feature resulting from the use of a differential area principle, which eliminates the need for high spring loading. Booklet has complete engineering data, many illustrations and installation and design data.

(21) HYDRAULIC SERVO SYSTEMS—Standard Controls, Inc., Bulletin 6, 4 pp. Presents a discussion of servo fundamentals as related to the hydraulic control field. Gives the advantages of pressure-control in the design of automatic control systems. Graphs give open loop frequency characteristics for a position servo and a velocity servo.

(22) SET SCREWS—Set Screws & Mfg. Co., Catalog 16, 22 pp. Has complete specifications and dimensions on: hexagon socket set screws; slotted headless set screws; fluted socket set screws; hexagon keys; pipe plugs; socket head cap screws; stainless steel

If your product requires the valving of "hard-to-handle" fluids...

HILLS-McCANNA
Saunders Patent
diaphragm valves
provide
the answer

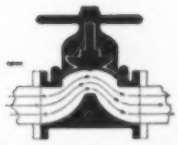
Leakproof valving of air . . . corrosive materials . . . slurries . . . solids . . . volatile and viscous substances

Hills-McCanna Diaphragm Valves can eliminate the problems involved in valving many of the so-called "hard-to-handle" fluids. By employing a simple pinch clamp principle, Hills-McCanna valves put an end to leakage, repacking and contamination.

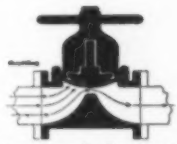
Hills-McCanna Valves are available handwheel or lever operated or for operation by pneumatic or hydraulic cylinders, diaphragm motors, electric motors, etc. Choice of 14 diaphragm materials, 49 body materials. Sizes from ⅜" to 14". Suitable for pressures to 150 psi., temperatures to 180° F. (higher with special materials). Screwed or flanged connections.

Write for Catalog V-52, HILLS-McCANNA CO., 2444 W. Nelson St., Chicago 18, Ill.

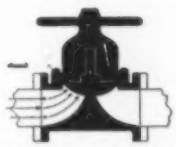
THIS SIMPLE PRINCIPLE ASSURES POSITIVE LEAK TIGHT VALVING



Compressor is raised, lifting diaphragm by means of a stud molded into the material.



Compressor and diaphragm partially lowered. Compressor design guides and supports diaphragm.

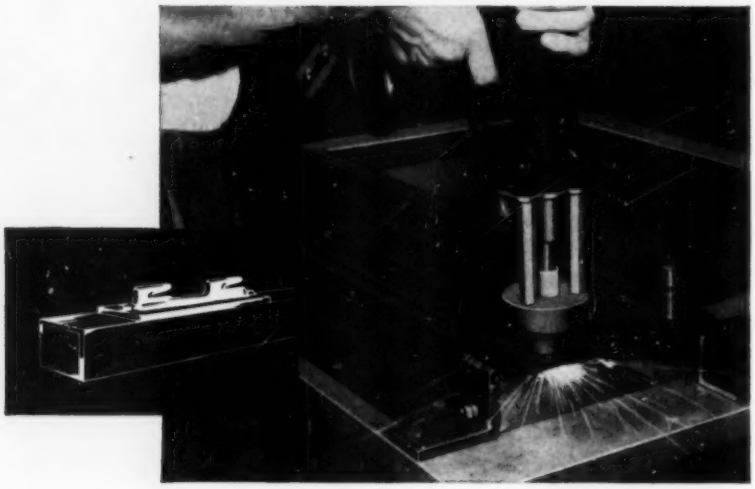


Compressor presses diaphragm tightly against weir, pinching off flow and making a tight seal.

HILLS-McCANNA
saunders patent diaphragm valves
Also Manufacturers of Proportioning Pumps
Force Feed Lubricators • Magnesium Alloy Castings

improved stud welding
through **KSM** engineering

ENGLANDER COMPANY SAVES $10,000 PER YEAR...



with change-over to

KSM ARC WELDED **STUDS**

Large production schedules keep the **Englander Company, Inc.,** Chicago, one of the largest manufacturer of metal beds and bedding products, constantly alert for cost-cutting manufacturing methods. This continuing search by **Englander** recently solved a difficult assembly problem when they put stud welding in their assembly line.

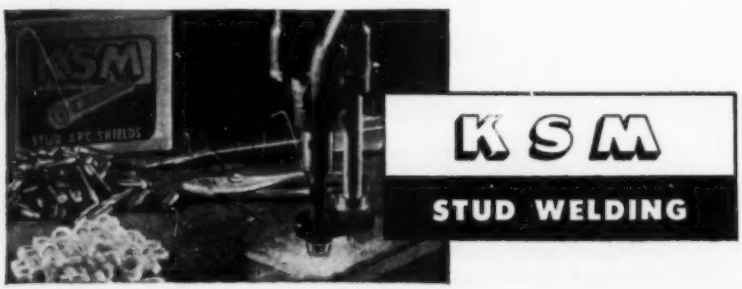
KSM Arc Welded Studs provided the fast, low-cost answer to the problem of securely fastening a spring support to hollow metal bedposts without marring the inside surface.

By changing to KSM Studs, drilling, supporting, peening and hand-filing were eliminated. Estimated savings produced by the change-over to KSM Arc Welded Studs, according to the **Englander Company,** amount to $10,000 on a yearly basis.

How The Problem Was Solved

A simple jig locates two KSM welding studs on each post within a tolerance of .02 inches and positions them perpendicularly. Welds are made instantaneously by merely pulling the welding gun trigger. The precision-centered solid flux, a feature originated by KSM, assures welds that withstand the required 30 foot-pound torque. The spring support is placed on the studs and securely fastened with two nuts.

KSM Arc Welded Studs make the tough, heavy-duty fastening jobs easy and fastening costs lower. Get the benefits of KSM engineering for your stud welding problems. Write KSM Products, Inc., Merchantville, N. J.



set and cap screws; self-locking set screws; hexagon head set screws; slabbed head set screws; and special products.

(23) SPRINGS—Illinois Coil Spring Co., Bulletin, 8 pp. Has many illustrations of the wide variety of the coil and flat springs, and wire forms that are made. Compression, extension, and torsion springs are available. Cold coiled springs from 0.005 in. to ½ in. round wire, and heavy hot wound springs of any size up to 1⅛ in. dia. bars.

(24) DUCTILE CAST IRON—American Brake Shoe Co., Booklet, 12 pp. Properties, characteristics, and applications are described for three standard grades of ductile cast irons. Has curves, charts and illustrations of typical castings for use in chemical, diesel, and general industrial fields.

(25) SWITCHES—Wells Sales, Inc., Catalog C-11, 16 pp. Devoted entirely to switches, more than 150 types are illustrated including: toggle and leaf switches; miniatures; plunger types; roller and wafer switches; vacuum pressure; circuit breakers; timers; and others. Specifications are given for each.

(26) GEAR MOTORS — General Electric Co., Bulletin GEA-1437H, 16 pp. The function, design, and application of gear motors with ratings from 1/6 up to 200 hp are described, along with many cutaway drawing that show the positioning of the parts. Adaptability to low-speed jobs and adjustable-speed drives are explained. Completely illustrated.

(27) CAPACITORS & PULSE FORMING NETWORKS—Aircraft-Marine Products Inc., Bulletin, 28 pp. Has design and test data on capacitors and pulse forming networks, and gives information on all the important features of these components. Also has data on a new synthetic dielectric, offering savings in capacitor size and weight.

(28) HARD FACING—Cleveland Hard Facing, Inc., Booklet, 4 pp. Describes the method of applying hard alloy metal to a low alloy steel base at areas of wear. Hard facing alloys

are applied to lineal, cylindrical or contoured shapes. Has illustrations of various parts hard faced.

(29) ROTARY AIR PUMPS—Leiman Bros., Inc., Catalog 752. Details of 4-wing and 2-wing positive air and vacuum pumps designed for applications requiring up to 29.9 in. vacuum and 25 psi. Tables of vacuum, pressure, and specifications given for each type of pump.

(30) RELAYS—Guardian Electric Mfg. Co., Catalog 10-C, 22 pp. Has illustrations, engineering drawings, and complete operating data on a-c, d-c, locking, and stepping relays. Among those covered are: small, multiple contact; coil spring contact; heavy duty, dual contact; telephone type; and midget telephone type.

(31) SHOCK MACHINE—The Barry Corp., Bulletin 533, 4 pp. Presents complete technical and performance data on the type 150-400 VD medium impact shock machine, designed to produce calibrated shock tests up to 77 g peak acceleration. Has detailed dimensions and data covering range of operation.

(32) FLEXIBLE METAL HOSE—Titeflax, Inc., Catalog 200, 48 pp. In addition to complete descriptions and specifications for flexible metal hose, fittings and assemblies, it has data on flexible metal conduit and ferrules, hose assemblies, ignition shielding, and other components. Has illustrations and cross-sectional views of most types.

(33) WIRE THREAD INSERTS—Heli-Coil Corp., Bulletin 652, 22 pp. Data on the uses of thread inserts in design and maintenance. Has new specifications covering class 2, 2B, 3, and 3B fits. Photographs, line drawings, and tables explain the use of inserts in all materials. Also insert specifications on various special thread series.

(34) DEMAND METERING—General Electric Co., Bulletin GET-2327, 48 pp. Describes in detail the theory, economics, operation, and application of demand meters. Has a summary of the principles and problems of demand metering, and may be used as a re-

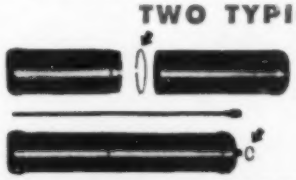
A SURE WAY to get fast, low-cost metal joining...

PREPLACE THE BRAZING ALLOY

ALLOY PREPLACEMENT is a key factor in the tried and proved EASY-FLO and SIL-FOS low-temperature silver alloy brazing formula that gives you *any brazing production you want* at surprisingly low cost. It's a simple abc formula... where a = assembling parts with EASY-FLO or SIL-FOS *pre*placed at the joints... b = using a fast heating method such as oxyacetylene torch, furnace, electrical induction, gas-air burners, etc.... c = devising a production set-up that keeps assemblies moving steadily to and through the heating station. This formula eliminates the human element from the actual brazing. It assures fast, reliable production with unskilled labor.

EASY-FLO and SIL-FOS are available in rings, washers, shims and other preformed shapes to suit specific joint requirements.

TWO TYPICAL EXAMPLES



NAVY BUZZER CASE COVER
8 posts and gasket brazed to cover with EASY-FLO wire rings preplaced. Assemblies go thru furnace 1500 a day.

INSECTICIDE BOMB
Steel shell stampings and copper vapor tube joined with rings of EASY-FLO preplaced. Two girls turn out 120 bombs per hour.

A BRAZING PRODUCTION EXPERT IS AT YOUR CALL Without obligation one of our field engineers will call and tell you if, where and how you can use the preplacement formula to advantage. Write and say when. *FOR FULL FACTS IN PRINT* write for a copy of BULLETIN 20...

HANDY & HARMAN

OFFICES and PLANTS
BRIDGEPORT, CONN.
PROVIDENCE, R. I.
CHICAGO, ILL.
CLEVELAND, OHIO
DETROIT, MICH.
LOS ANGELES, CAL.
TORONTO, CANADA
MONTREAL, CANADA

General Offices: 82 Fulton St., New York 38, N. Y.
DISTRIBUTORS IN PRINCIPAL CITIES

AT THE METAL SHOW — CLEVELAND — OCT. 19-23
SEE ... actual applications of the preplacement formula in action ... Also many more examples of EASY-FLO and SIL-FOS products and assemblies ... Let your metal joining problems with our experienced engineers.
BOOTH 941

LAMINATED SHIMS

SIMPLY PEEL FOR ADJUSTMENT

Shims stamped from brass or steel LAMINUM® *look and act like solid metal but they peel off in .002" (or .003") layers.*

Provide great accuracy yet allow easy machining tolerances

No counting

Speed production by simplifying your spacing adjustments

No stacking

Reduce lathe time; no standby machine required during assembly

No miking

Adjustments right at the job by peeling laminations with a penknife

Precision cut to your exact specifications, with careful quality control

URGENT! Save production time! Shims are more important now than ever!

SEND TODAY for our Engineering Data File

LAMINATED SHIM COMPANY, INC.

1410 UNION STREET • GLENBROOK, CONNECTICUT

CUSTOM SHIMS STAMPINGS SHIM STOCK

ference for helping in specific demand-measuring application. Has many illustrations and schematic diagrams.

(35) VARIABLE SPEED MOTORS —U. S. Electrical Motors, Inc., Bulletin 1797, 16 pp. With many colored, cutaway illustrations, it outlines the reasons why variable speed motors can be used to improve production. Has illustrations of all types of Varidrive motors, showing mechanical features, remote controls, and other points.

(36) ELECTROFORMING — Bone Engineering Corp., Booklet, 8 pp. Tells what electroforming is and where it is used. Illustrations compare parts made by electroforming, and those made by other methods. Tolerances of ± 0.001 in. are maintained. Physical properties of electroformed metals also given.

(37) MOTORS & GENERATORS—General Dynamics Corp., Bulletin 100, 12 pp. Detailed information on performance and dimensional data, along with product application data, plus charts to aid in the selection of motors for ordinary applications of polyphase squirrel-cage induction motors.

(38) PUSH-PULL CONTROLS—Arens Controls, Inc., Catalog Titled, "Guide to the Selection and Application of Push-Pull Controls," it contains practical engineering data, factors to consider in planning control applications, plus blueprints and illustrations of the various control models available.

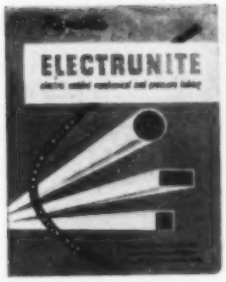
(39) RHEOSTATS—Hardwick, Hindle, Inc., Bulletin 353, 4 pp. Has complete engineering data and construction features of the 50, 75, 100, and 150 watt rheostats. Contact arm uses a new buss bar type brush which adjusts itself automatically to complete and continuous contact.

(40) TUMBLING—Tumb-L-Matic, Inc. Bulletin. Describes the wet process tumbling barrels used for deburring, cutting down, smoothing and burnishing forged, stamped or cast metal parts by tumbling the parts in water with abrasive materials. Covers drive mechanisms, electric controls, barrel construction, and specifications on 6 standard units available.

1. Here are all the facts on ELECTRUNITE E.M.T. Includes bending tools and accessories; dimensions and weights of tubing and elbows; facts on "Dekoron-Coated" E.M.T.

2. How to specify boiler, heat exchanger and condenser tubes is only one information-packed section of this 20-page booklet. Also includes allowable working pressures.

3. Handy wall chart with bending instructions for use with "Inch-Marked®" ELECTRUNITE E.M.T. Diagrams are large, easy to read, easy to follow. For quick reference.

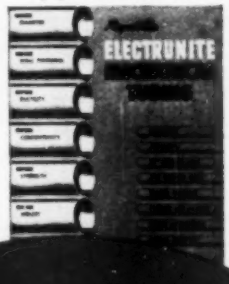


4. Product designers interested in mechanical and pressure tubing will find a lot of facts in this brochure. Pictured are many examples of products where costs were trimmed.

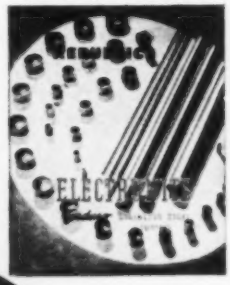
5. Sizes, dimensions and weights of ELECTRUNITE mechanical tubing, pressure tubing and electrical metallic tubing are included in this 8-page booklet. Also fabricating.

6. This handy chart puts size, gage ranges at your fingertips. Easy to carry in your pocket. Covers mechanical pressure and stainless tubing, along with stainless steel pipe.

7. Lots of help for design engineers in this 8-page brochure on Mechanical Tubing. Includes advantages; applications; size tolerance tables; gage tolerance tables.



8. Most of what you need to know about Stainless Steel Tubing and Pipe can be found in this 28-page booklet. Data on fabricating and finishing, how to lay out drawings.



9. Carbon and stainless tubing for the process industries are described in this booklet. Valuable laboratory corrosion data along with properties of Enduro Stainless Steel Tubing.

10. Product designers balked by the high cost of unusual tubular shapes will be interested in this booklet on the Dewey Process for configured tubing. Process is shown in pictures.

Here's Your FREE LIBRARY On Mechanical Tubing, Pressure Tubing, Stainless Steel Tubing And Pipe, And Electrical Raceways

11. When journeymen want instructions on how to bend ELECTRUNITE E.M.T. all you do is hand them this booklet of bending instructions. Pocket size.

12. Pictures and captions tell the story of how to use the Republic ELECTRUNITE E.M.T. 1¼" bender.

13. Some ideas on where to use tubing profitably are contained in this handy reference folder. Also contains size ranges.

14. Advantages of using "Dekoron-Coated" ELECTRUNITE E.M.T. are explained in this compact folder. Shows how easy it is to install this polyethylene coated raceway in corrosive atmospheres.

15. Eight analyses of stainless steel tubing, pipe and general uses.

16. Outstanding features of ELECTRUNITE E.M.T. are briefly described.

17. Complete engineering data on "Dekoron-Coated®" ELECTRUNITE E.M.T.

18. Advantage using ELECTRUNITE boiler, heat exchanger or condenser tubes.

REPUBLIC STEEL

ELECTRUNITE TUBING

CLIP COUPON AND MAIL TO:

REPUBLIC STEEL CORPORATION, *Steel and Tubes Division*
East 131st Street, Cleveland 8, Ohio

Name ..... *Position* .....
Company .....
Address .....
City ..... *Zone* ..... *State* .....
Please send me the following literature (circle numbers desired)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Make it a point—USE MARS-LUMOGRAPH "TECHNICO"

It's a strong point in your favor when you use the **1001 MARS-LUMOGRAPH TECHNICO** lead holder, the new precision-engineered holder that has these strong points in its favor:

1. Noiseless, smooth-working, low-friction clutch mechanism.
2. Lightweight wood construction with perfect balance.
3. Can be completely disassembled; individual parts replaceable.
4. A novel safety feature that prevents leads from slipping.

Far superior to domestic styles, the **TECHNICO** costs no more than ordinary holders. Imported from Germany, the **MARS TECHNICO** is the product of 300 years' experience in superior pencil craftsmanship. Get your **TECHNICO** from your dealer today.

A fine lead sharpener built into the push-button cap

1904 MARS-LUMOGRAPH imported drawing leads in 18 degrees are rifled to assure a perfect grip, do not flake, will not smudge. 10 cents each—less in quantity. Cost no more than domestic brands.

SINCE 1662
J.S. STAEDTLER, INC.
53-55 Worth Street
NEW YORK 13, N.Y.

Sans, Souci

Ad Libbing by the Editor

It was in about 1910 or 1912 that I listened to an interesting discussion between two men about the future of the aeroplane, as it was then called. At that time, the aeroplane was still the big attraction at the county fairs. The hardy pioneers who piloted the frail craft were mostly interested in stunting because that was their only source of revenue. A non-stop flight from Albany to New York City, following down the Hudson River, made the newpaper headlines.

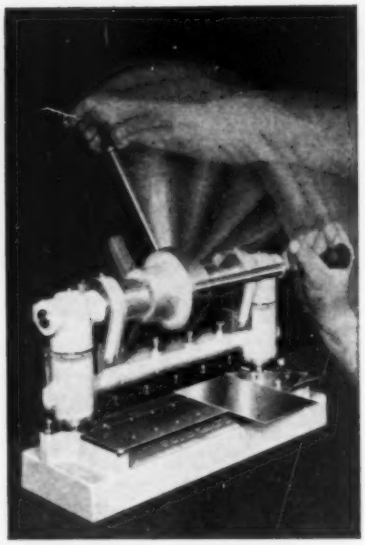
One of the men in this discussion was an aviation enthusiast. He predicted:

"Charlie, some day they'll fly the ocean and carry passengers and freight just like the steamers, and they will make the trip to Europe in less than a day ! ! !"

"I am afraid you're just a little over enthusiastic, Jim", answered Charlie, who incidentally prided himself on his smattering of scientific knowledge. "You see, Jim, when you start figuring it out you just can't get the right answer.

"In the first place the aeroplane would have to carry so much gasoline that it couldn't possibly carry passengers besides. In fact, the aeroplane could probably never carry enough gasoline to take it all the way across the ocean. Now, there are some folks who are figuring on anchoring great big floating islands out in the ocean so that the aeroplanes can land on them and fill up again with gasoline. Also, the islands would be placed where the ships could land in case of a storm. But those islands would cost so much money that they wouldn't be worth it.

"Now, there is another thing, and that is the changes in the weather. It would be impossible to maintain any kind of flying schedules because a plane can only fly in the best kind of weather. So any trip schedules by aeroplane would be unreliable and that would make the whole thing impractical. Besides that, the amount of weight that the plane could carry, only a couple of hundred pounds, at the best, would make the whole venture unprofitable. On top of that, people



Want PRECISION SHEARING at HIGH SPEED?

Check these features and you'll want a DI-ACRO* SHEAR

- **PRECISION** — strips less than .025" wide accurately sheared. Thousands of parts exactly duplicated.
- **CUTTING SPEED**—rivals that of power machines.
- **RATED CAPACITY**—16 gauge.
- **EASY TO OPERATE**—a woman can operate it.
- **CHOICE OF MODELS**—available in four sizes. Widths from 6 to 24 inches. Four power models also available.
- **ENGINEERING SERVICE**—always at your disposal.
- **PORTABLE**—readily moved.
- **RUGGEDLY BUILT**—backed by one year warranty.
- **DELIVERY**—immediate on most models.
- **COST**—that's good too.

*pronounced Die-ack-ro

METALS · RUBBER · MICA · FIBRE · PLASTIC · LEATHER · SCREEN MESH

LIKE MORE INFORMATION?

Send for 32-page catalog

Gives full details on both hand and power operated Di-Acro Shears, Benders, Brakes, Notchers, Punch Presses, Rod Parters and Rollers. Mail your request today.

Creators of "DIE-LESS DUPLICATING"

di-acro PRECISION METALWORKING MACHINES

O'NEIL-IRWIN MFG. CO.
333 8th AVE.
LAKE CITY, MINN.

would be afraid to fly because there would be too much danger so that there wouldn't be any traffic except for a couple of foolhardy people who would be willing to take a chance."

We all know what happened. The above conversation simply illustrates that it is easier to say no than yes.

In every discussion where a new proposal is being considered we find the group usually splitting up into three sections, the "ayes," the "nays" and the sparrows. The last group sits on the fence, chirps a little now and then and once in a while one of them will jump down off the fence on one side or the other and pick up a few crumbs of credit for something that they had nothing to do with.

Sparrows always play safe. As a matter of fact, they are playing the safest because no matter what develops or what conclusion is reached, they can always claim, "That's what I said." They are a sort of a safety valve.

The Nay Boys Talk Loudest

The "nay" boys are the ones who are positive. They can speak with great assurance. In fact, many of their arguments will be indisputable and there is no answer to many of their claims. That is because a lot of their stuff they fish out of the blue sky, just like Charlie did who had six reasons why trans Atlantic commercial plane traffic was impossible. Unfortunately, the "nay" boys are in a safe position. That is why there are so many of them. It is never possible to prove what would have happened if something else had been done. If the "nay" boys win and the proposal is not carried out they can always claim that the carrying out of the proposal would have entailed a great loss. If the proposal is carried out and proves profitable the "nay" boys can always point to some changes that made it "entirely different" from the original idea.

The "aye" men are the ones who are in the most dangerous situation. They are the ones who have to be absolutely certain of their facts. If the proposal is accepted and failure results, they and they alone will bear the blame. The "no" boys will be quick to blow their horn, pointing out that if they had been listened to the great loss would have been avoided. The sparrows will chirp, "I told you so".

It takes courage to get behind a pro-

Are you SURE you're using THE MOST EFFICIENT FINISH?
If your production involves finishing zinc, cadmium, aluminum or cuprous metals, you owe it to yourself... and your customers... to investigate
IRIDITE
for on any of these metals Iridite gives you a high performance finish at a low cost from a simple chemical dip.
IF YOU WANT HIGH CORROSION RESISTANCE,
you'll find an Iridite that will meet any military or civilian specifications for chromate finishing.
IF PAINT ADHERENCE IS IMPORTANT,
you'll find Iridite prevents underfilm corrosion and soap formation.
OR, FOR BRIGHT, DECORATIVE FINISHES—
investigate zinc plate and Iridite (Bright) for a chrome-like decorative finish with more corrosion protection than conventional chrome plating . . . or Iridite (Metcote) as a treatment for copper that eliminates the need for buffing in the copper-chrome system; produces a sparkling bright finish!
Write for literature and send us samples for test processing. See "Plating Supplies" in your classified telephone directory or write direct.
Iridite is approved under government specifications.
ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

in considerable volume, you may profitably make it yourself from coiled strip on a small, compact Yoder electric-weld tube mill. Daily production from 25,000 to 50,000 feet with only one operator and a helper. Amazingly simple and trouble-free, the new 4-in-1 Yoder welding transformer insures highest output of quality tubes at lowest cost per foot or mile.

Yoder Tube Mill Book tells complete and interesting story of the Yoder method and answers most pertinent questions about first cost and operating cost, minimum requirements for profitable operation, skill and training of operators, power consumption, weldable materials, tooling, etc. Send for it.

Latest Yoder development: Highly economical new process of making *aluminum, brass* and *other non-ferrous tubing* by cold forming and welding of coiled strip. Details on request.

THE YODER COMPANY
5522 Walworth Ave.
Cleveland 2, Ohio

Electric Weld
TUBE MILLS

posal and stake your future on its success. The pity of it is that there have been many instances where the man who proposed the idea that was accepted, was not permitted to carry it out. The idea was turned over to someone else to carry it out. And because it was not carried out the way the originator had it in mind, it failed. The fellow who originated the idea was then blamed, not the fellow who failed to do the job right.

It is awfully easy to get the wrong slant on a new idea, especially if the idea involves intangible factors and its fulfillment requires artistic skills.

Inconsistent Man

A most difficult thing to determine is the likes and dislikes of that strangest of all animals—man. He is just too darn educated to follow set formulas. He is also too emotional to react consistently to the same impulse. And finally, the degree or magnitude of the factors involved will have a tremendous influence on his actions.

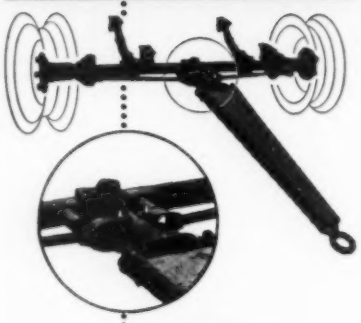
A man may like spaghetti but if you put before him a huge dish of it the sight of it might cause in him a quick loss of appetite. A man may be terrifically fond of mystery stories. If you happen to ask him how he likes them, at a time when he has just finished one that in his estimate was considerably below par, he will probably tell you that he hates them.

Because the meaning of words and the significance of statements change with the state of mind, it is well nigh impossible to convey an intangible idea to the mind of another person and have it pictured in that other person's mind exactly as it is in your own mind.

I well remember the terrible time trying to educate Big Frank to modern inventions and design. It was extremely hard to wean him over to new ideas even if those ideas were material and mechanical. For example, his chief engineer had an awful time trying to get Frank to accept hydraulic or electrical operation.

One of the elements of Big Frank's railroad-maintenance machine involved a linear motion. Big Frank wanted to do it with clutches, reversing gears, universal joints, screws and a terrific conglomeration of mechanical

UNITED CARAVAN AXLES



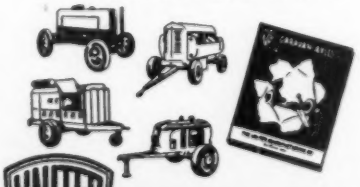
feature
AUTOMOTIVE STEERING

● Only CARAVAN axles with automotive steering assure dependable roadability on both highway and rough ground. For positive trail at high speeds, these job-engineered assemblies feature controlled camber, tow-in and caster.

Stability for the heaviest loads is provided by massive center steering arm, extra-heavy center arm stop blocks and heavy duty steering knuckle. Wide inside wheel turning angle assures maximum maneuverability and eliminates jack-knifing.

CARAVAN units are available in a variety of types and sizes in both 2 and 4-wheel assemblies for portable equipment weighing from 500 to 14,000 lbs. They are recommended for use with military and industrial as well as field service and construction equipment. UIS-UM

Write today for the new Bulletin No. 53 for further information.



UNITED MFG. COMPANY
1021 W. INTERSTATE ST. • BEDFORD, OHIO

elements. His engineer demurred and suggested hydraulics, giving as an added reason that the straight line motion was on another moving element and it would be difficult to power the straight line motion from the main drive shafts. Big Frank insisted that he was going to have nothing to do with hydraulics. As he put it:

"When you drive it with shafts and gears and chains and such stuff and something stops you can always see where it stops and that is where you find where it is broken. So you know where it is broken and what is broken, and you can put in a new piece."

There was much logic in Big Frank's argument. He was dealing with operators who were brought up in the school of mechanics rather than hydraulics and electricity.

In this case, the engineer was up against it. Without saying anything he designed the straight line motion to be hydraulic. Big Frank screamed to high heaven when he found that his orders had been disobeyed, and that hydraulics were being used. As luck will have it, when the hydraulic system was first installed the mechanics made a mistake and got the lines mixed. The piston didn't work. Big Frank bellowed. Finally everything was straightened out.

It was about three months after the machine had been put into operation when Big Frank said to his chief engineer:

"Jim, you remember that hydraulics stuff? You know, the operator just pushes the lever and the thing moves out and stops where it should, and if the operator keeps on holding that lever over, nothing happens. Then when he wants to make it go the other way he pushes the handle over to the other side and the thing moves the other way and stops where it should, even if the man pays no attention to what he is doing. Why don't you make all the stuff work that way?"

That was the way Big Frank complimented others. He rarely apologized in the usual manner. He always resorted to some round-about way to let the other fellow know that he greatly appreciated what had been done. But of course the incident also illustrates one of Big Frank's big weaknesses. He rarely had the patience to listen thoughtfully and uninterruptedly to a new idea. —G.F.N.

hot . . . or cold

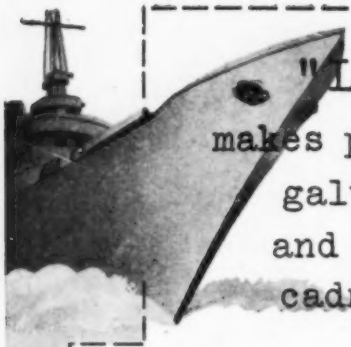
Over frozen ice fields or scorching deserts, the delicate mechanisms of Kollsman products must function with accuracy and rugged dependability.

- AIRCRAFT INSTRUMENTS AND CONTROLS
- OPTICAL PARTS AND DEVICES
- MINIATURE AC MOTORS
- RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT

Current production is largely destined for our defense forces; but our research facilities, our skills and talents, are available to scientists seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORP.

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO., INC.



"LITHOFORM"®
makes paint stick to galvanized iron and other zinc or cadmium surfaces

PROBLEM:

To eliminate the peeling of paint from zinc and zinc-coated structures or products.

SOLUTION:

Treat all zinc surfaces with "LITHOFORM" before painting. "LITHOFORM" is a liquid zinc phosphate coating chemical that can be applied by brushing or spraying at the Yard, or by dipping or spraying in industrial equipment. "LITHOFORM" forms a durable bond for paint. It is economical; it eliminates frequent repainting; it protects both the paint finish and the metal underneath.

ACTION:

Send for our new descriptive folder on "LITHOFORM" and for information on your own particular metal protection problem.

"LITHOFORM" meets Government Specifications. Specify "LITHOFORM" for all painting and refinishing work on zinc and zinc-coated surfaces.

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

AMBLER, PA.

Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

Detroit, Michigan Niles, California Windsor, Ontario

American Chemical Paint Co.
Ambler, Pennsylvania

Gentlemen:

Please send me a free copy of your descriptive folder on "LITHOFORM."

NAME.....

COMPANY NAME.....

ADDRESS.....

CITY..... STATE.....

ENGINEERING ABSTRACTS

Diecastings and Extrusions

Abstracted from "Diecastings and Extruded Sections" by H. K. and L. C. Barton. Mechanical World, June 1953.

BOTH OF THE ABOVE PROCESSES have their specific advantages and limitations, making the methods complementary rather than competitive. Although the section may be of complex form, extrusions are characterized by sections which for all commercial purposes must remain constant. The extrusion of tapering aircraft spars is a specialized development which is not capable of wide application. Extrusions may be used in long lengths for structural elements or decorative trim, or they may be cut into transverse plates or blocks of constant thickness.

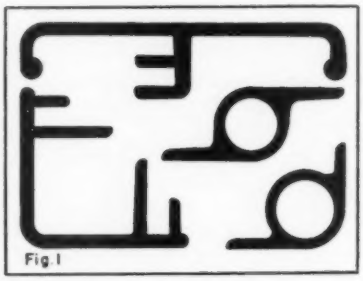


Fig. 1

SOME representative extruded sections.

Diecastings, by contrast, can be irregularly formed in three dimensions, with certain reservations regarding cored holes and undercuts that might prevent removal of the part from the die. The parts are also limited to overall size. Diecastings usually do not exceed their width by a factor of more than ten, particularly in the larger size range, because of the difficulty of maintaining good surface finish and internal homogeneity. Also, overall size is limited by the size of the machine used. The acceptable limit today is that a diecasting must be encloseable within a prison of 40 in. by 20 in. by 10 inches. These limits are set by the platen area, stroke, and the hydraulic pressure.

Diecastings are the least satisfac-

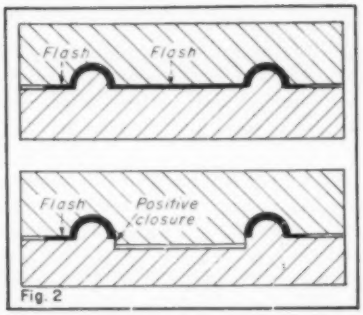


Fig. 2

HIGH LOCKING PRESSURES are required when a component has a large internal flash area as in the top sketch. For large diecastings it is desirable to adopt the construction of the lower sketch and so reduce the pressure area.

tory in components that differ little in length, breadth and thickness; such a quality is called "squatness." The more a part approaches cubical or spherical form, the more difficult is its production. This results from a number of operational factors, the end effect being a low rate of heat transfer as a result of their low surface/volume ratio, and the possibility of voids due to air present in the die cavity.

Squat components of relatively constant thickness are better produced in many cases from extruded stock rather than as diecastings. An example is the component illustrated in Fig. 3, which was originally produced as a diecasting in aluminum alloy. The narrow slot and three holes were cored. Because of the heavy section, it was necessary to run the die at a slow rate to prevent molten metal from bursting into the slot as the core was withdrawn on the opening stroke of the die. In this component the slot accentuated, rather than reduced, the difficulties caused by the heavy section.

When production was converted to extruded stock, it involved cutting to thickness, rather than length, milling

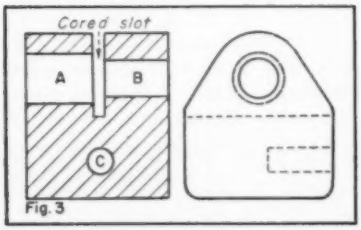


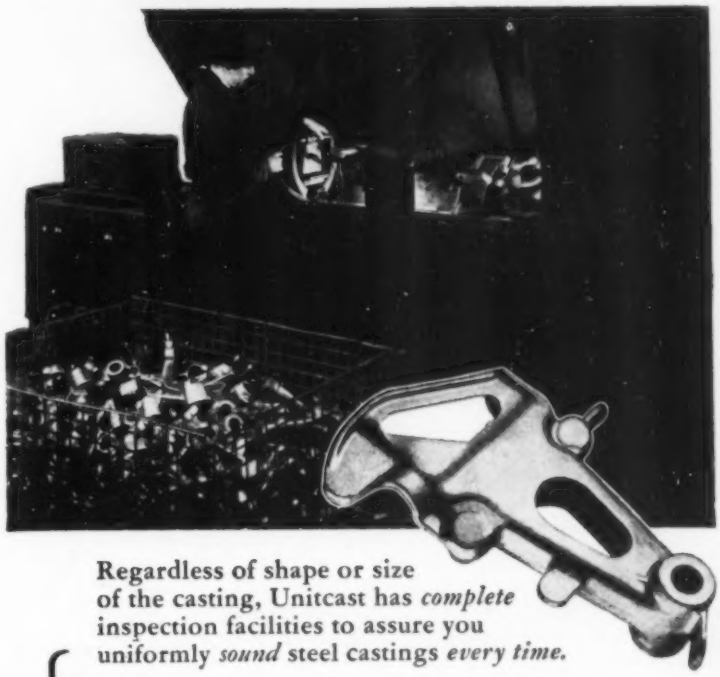
Fig. 3

A COMPONENT of exceptionally heavy section, difficult to produce satisfactorily as a diecasting.

NO. 3 IN A SERIES

UNITCASTINGS are consistently better!

WE CAN TEST 'EM ..every which* way!



Regardless of shape or size of the casting, Unitcast has *complete* inspection facilities to assure you uniformly *sound* steel castings *every time.*

* Magnaflux . . *either the wet or dry method.*
Magnaglo . . *particle inspection (or Zyglo).*
Gamma Ray or X-Ray . . *we can "see through" your casting.*
Mechanical . . *yes, we section-cut to check internal soundness.*

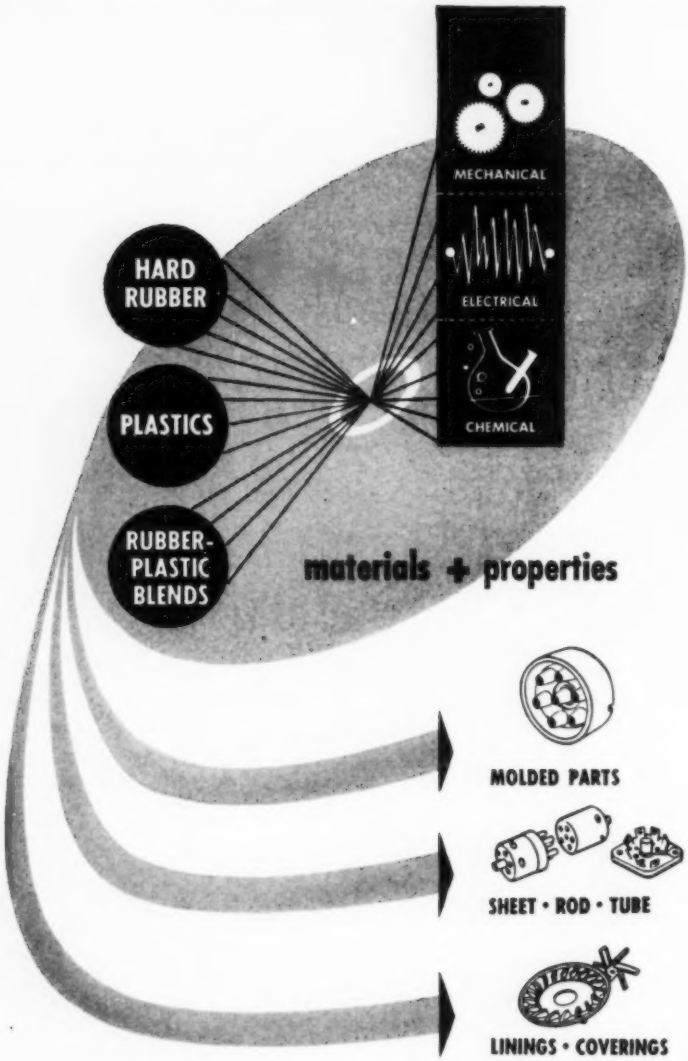
Whatever inspection method is needed on *your* steel castings, *we have it!* Another example of the *thorough quality control* you get at Unitcast.

UNITCAST Corporation
QUALITY STEEL CASTINGS

Our steel casting specialists welcome the opportunity of working with you on your parts problems... their suggestions at the design stage can pay you continuous dividends.

Write or call . . . Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio; 701 New Center Bldg., Detroit, Michigan; In Canada: Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS are FOUNDRY ENGINEERED



ace® is not just one material

Ace means *tailor-made* rubber and plastic materials . . . with mechanical, electrical and chemical properties carefully blended to give you the *one* best material and most economical production methods for your designs. Hundreds of Ace rubber and plastic compounds to choose from—plus many unusual materials like Ace-Tex pyrobitumens and Ace-Hide rubber-plastic blends. Among world's largest molding, extruding, fabricating facilities.

80-Page Ace Rubber and Plastics Handbook Free to Design Engineers. Write today.

ACE rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

slot and drilling hole C. The hole A-B was formed in the extrusion (to the smaller diameter B) and the A end counterbored. Also, when cut from an extrusion, there were no porosity difficulties.

In appropriate instances diecastings and an extruded section may be used in conjunction; a length of extruded stock, either straight or formed to shape, can be used as an insert in a diecast component to produce features difficult to achieve by diecasting alone.

Since diecastings and parts machined from extruded stock can both be formed to intricate profiles in one plane, the advantages of extrusions progressively diminish as the components become more complex in other planes. One can grade extrusions by the number of separate machining operations required. While not completely decisive, in general, the more machining required, the more likely is diecasting the better choice.

Nuclear Radiation and Mechanical Properties of Metals and Plastics

Abstracted from "Effects of Nuclear Radiations on the Mechanical Properties of Solids", by G. J. Dienes, Brookhaven National Laboratory, Journal of Applied Physics, June 1953.

NUCLEAR RADIATIONS can drastically alter the properties of solid materials. In crystalline substances, mostly metals, the changes in mechanical properties can be attributed to the production of interstitial atoms and vacant lattice sites by fast particle irradiation. In molecular solids, mostly high polymers, nuclear radiations induce changes in which ions and free radicals are formed leading to subsequent chemical reactions. Drastic changes in their mechanical properties are also induced.

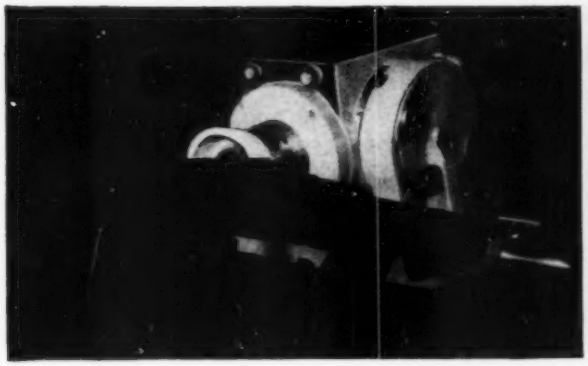
Crystalline Solids

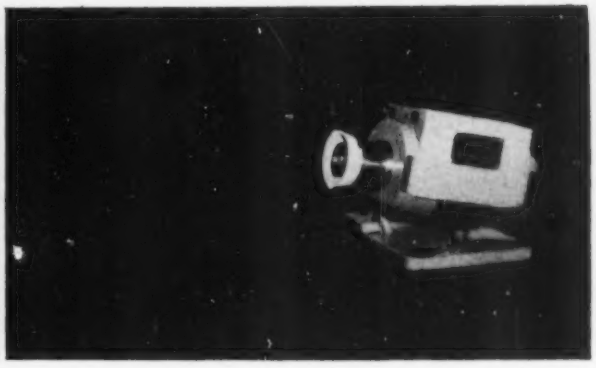
Recent theoretical work indicates that the presence of interstitial atoms will result in appreciable increases in the elastic moduli, at least for closely packed metallic lattices.

In copper, for example, the presence of a small fraction of interstitials and vacancies results in large increases in the elastic moduli, 5-7 percent for one percent interstitial. Lattice vacancies alone were found to decrease the elastic moduli, the change being essentially

Specify THIS NEW **POPE** SUPER PRECISION 1 HP, 3600 RPM MOTORIZED TOOL AND CUTTER GRINDER CLEARANCE ANGLE SWIVELLING HEAD

With Angular Adjustment In A Vertical Plane





TIME AND MONEY SAVING FEATURES:

1. Cup wheels, generally considered best for cutter grinding, can be used for practically all clearance angles on this new head.
2. Cup wheels produce a cutting edge on tools that lasts longer because it is stronger.
3. The tooth rest remains on the center line of the cutter for practically all grinding on centers or in the work head.
4. Most cutters and reamers can be ground all over with one set-up, using the swivelling table and Pope tilting head. The usual second and third set-ups are no longer required.
5. All clearance angles read directly in degrees from the scale provided on the head. Mistakes on clearance angles are avoided.
6. The right clearance angle is assured on tools difficult to grind, such as slab mills, taper reamers, angular cutters and form tools.
7. 3600 R.P.M. — one wheel speed — safe for all wheels generally used on cutter grinders. Heat checking of cutters is virtually eliminated.
8. The operating ease and convenience of this new Pope Head with the angular adjustment in the vertical plane saves you time and money on every tool you grind.

ASK FOR COMPLETE SPECIFICATIONS

No. 96

Specify **POPE** PRECISION SPINDLES

POPE MACHINERY CORPORATION

NEW

FRACTIONAL HORSEPOWER DINGS MAGNETIC BRAKES

SELF-ADJUSTING!
LONGER-LASTING!
COMPACT!
RUGGED!

- 1½, 3 and 5 lbs. ft. torque.
- For all standard AC and DC motor voltages.
- Dust-tight, waterproof and explosion-proof enclosures available.
- Floor or motor mounting.
- Continuous duty.

New Dings Brakes now available 1½ to 90 lbs. ft. torque.

Self-Adjusting for Wear. New Dings fractional horsepower magnetic brakes automatically compensate for wear, requiring no adjustment for up to a million and a half stops.

Adjustable for Torque. Although the brake automatically adjusts for wear, critical adjustment of torque can be made to secure precisely timed stops.

High Thermal Ratings. The exceptionally high thermal ratings of Dings brakes make possible longer life and more stops per minute from a given size brake.

Compact. Dings brakes are space savers.

Rugged. Dings brake housings are cast iron, covers are cast aluminum.

Save Mounting Time. Dings brakes do not have to be disassembled for mounting, saving from 10 to 30 minutes labor.

Simple—Direct Acting. No solenoids nor lever linkages. All brakes are equipped with manual release.

Write today for complete data on Dings fractional and integral horsepower brakes.

d/b

DINGS BRAKES, INC.
4715 W. Electric Ave., Milwaukee 46, Wis.

A SUBSIDIARY OF DINGS MAGNETIC SEPARATOR CO.

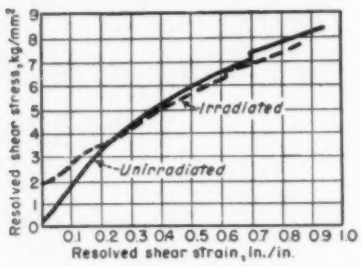


Fig. 1—Stress-strain curve of copper.

a bulk effect. Consequently, increases in the elastic moduli are to be attributed primarily to the presence of interstitial atoms. The theoretically predicted effects should be easily observable experimentally in copper and similar metals provided thermal annealing is prevented. Preliminary experiments indicate that Young's modulus of copper increases by as much as 10 percent upon heavy clyclotron irradiation.

A considerable amount of work has been done on the influence of radiation on the plastic properties of metals. It has been established that an increase in hardness resulting from irradiation is a general phenomenon. The work on single crystals of copper shows very clearly that the major effect of radiation is to alter greatly the critical shear stress. Stress-strain curves obtained on irradiated and unirradiated crystals are shown in Fig. 1. The critical shear increased from 0.241 to 2.0 kg/mm² for a fast neutron flux of about 2×10 nvt^{18}. (NVT designates the number of neutrons per cm² incident on sample; N_v = flux in neutrons per cm² per second; t = irradiation time in sec). After appreciable plastic deformation, the differences in the stress-strain curve essentially disappear. It is clear that after cold work the effect of irradiation is much smaller than for annealed samples.

The shape of the stress-strain curve after irradiation is similar to that produced by solid-solution harden-

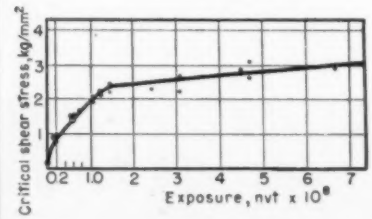


Fig. 2—Neutron bombardment effect on critical shear stresss of copper.

ing, for example, by zinc in copper (α-brass). Further, critical shear stress vs bombardment curves, shown in Fig. 2, indicate strong similarity to shear hardening by dissolved impurities.

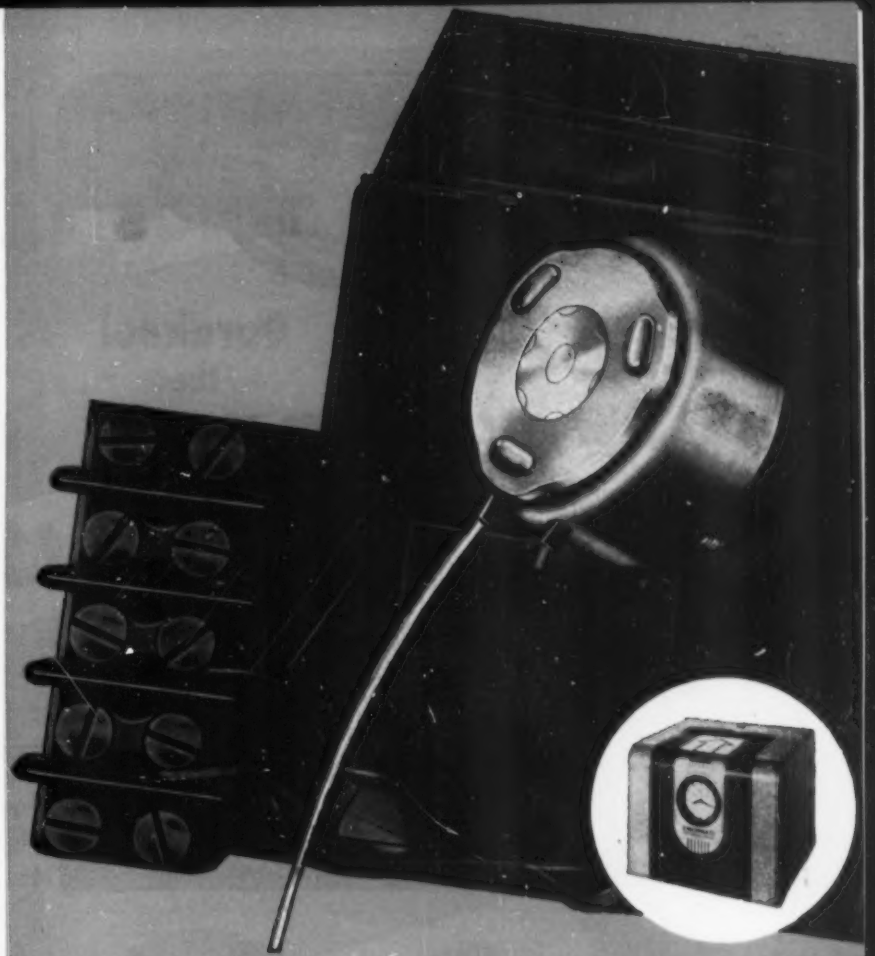
It is very difficult to estimate theoretically the effect of radiation on creep rate. One experiment measured the creep rate of cadmium under α-particle bombardment from polonium and found an appreciable increase in the creep rate, particularly during the early stage of the creep process. More recently, another experiment found no change in the creep rate of copper while the sample was bombarded by deuterons. Thus, experiments so far are not consistent.

It has been noted that there are similarities between cold-work hardening (strain hardening), and radiation hardening. This sort of parallelism carries through in other properties also. Electrical resistivity, for example, increases as a result of irradiation as well as of cold work.

A complex set of phenomena may arise when alloys are irradiated. Either via the production of vacancies and interstitials or via thermal spikes, local atomic interchanges (microscopic diffusion) may be promoted by irradiation. As far as the mechanical properties are concerned, the precipitation hardening alloys are of particular interest. Radiation hardening in solution annealed samples of a copper-beryllium alloy is much greater than in pure copper. Resistivity increases are also quite large. In general, the more beryllium there is in solution the greater is the effect of irradiation. These findings suggest that segregation or precipitation nucleation processes occur during irradiation.

Molecular Solids

In general, discoloration, brittleness, chemical decomposition, and many other changes may result from pile exposure of plastics. A large number of plastic materials has been classified empirically into 12 groups in order of decreasing radiation resistance. Mineral filled phenolics apparently withstand radiation best. Among the unfilled polymers, polystyrene is outstanding. In both materials, the well-known stabilizing influence of benzene rings is apparent. At the other end of the scale, methyl methacrylate, halogenated polyethylenes, and cellulosics



LEDEX ROTARY SOLENOIDS

... double efficiency and LOWER COST 70%

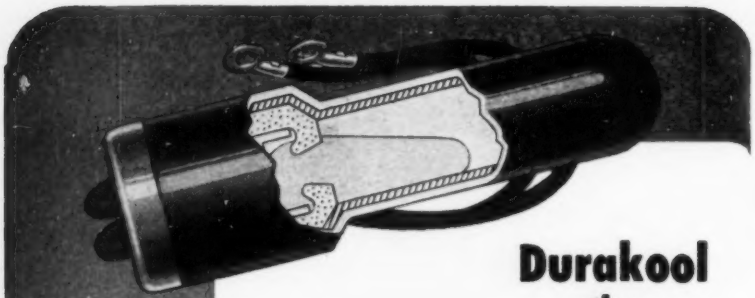
for The Cincinnati Time Recorder Company

The compact, powerful number five Ledex Rotary Solenoid is used to replace the bulky old type solenoid in the Cincinnati series 800, Automatic Time Recorder. By comparison Ledex Rotary Solenoids have 1/7 the weight . . . produce twice the power output with the same electrical input . . . proved to be more dependable and easier to install . . . *and reduced the cost of this component 70%*. The actual size illustration of the solenoids show the advantage of Ledex compactness . . . 1/6 the volume.

Let Ledex Engineers assist you in choosing rotary solenoids that will save production costs and help increase the efficiency of your products. Six basic models range in diameters from 1⅛" to 3⅝", with torque values from ¼ to 50 pound-inches. Various power linkages and types of mountings are available. Write today for descriptive literature.

G. H. Leland INC.

123 WEBSTER STREET, DAYTON 2, OHIO



Durakool
the
STANDARD
OF QUALITY, DURABILITY AND LIFE

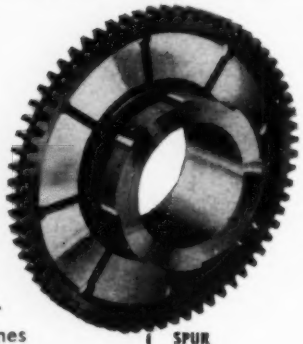
WITHSTANDS HIGH TEMPERATURES

Years of trouble-free performance on the most difficult of assignments have won top recognition for Durakool Mercury Tilt Switches. High temperatures, fast cycling and 24 hour schedules taken in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

See telephone directory for local distributor or write
DURAKOOL, INC. — Elkhart, Indiana
50 St. Clair Ave., W., Toronto

Durakool ALL-STEEL MERCURY Switches

GEARS GALORE



In over 45 years of custom-gear making, we've produced gears for thousands of different uses and products. We've made gears for diesel engines and driers and drilling equipment; for machine tools and marine drives and medical equipment—gears of all types and sizes, for all kinds of jobs. We've learned from experience that no two gear requirements are entirely identical—that each gearing problem requires a separate solution. And from this variety of experience we've gained the ability and "know-how" to produce the *right* gear for any job you might have.

SPUR
WORM
INTERNAL
SPIRAL BEVEL
HELICAL
HERRINGBONE
*CONIFLEX BEVEL
SPLINE SHAFT

*Reg. U. S. Pat. Off.

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Marlemont Ave. • Cincinnati 27, Ohio

are extremely poor in their resistance to radiation.

As far as the mechanical properties are concerned, changes in stress-strain curves as a function of irradiation are the most revealing among the properties studied (stress-strain, impact and shear strength, hardness). One generalization may be made which is almost universally valid for all the high polymers studied. The elongation at break is drastically reduced by irradiation, i.e., the material loses its plasticity and can no longer be cold-drawn. This change is strikingly illustrated by the curves of Fig. 3 for polyethylene. The irradiation dosages are indicated along the curves in terms of the total number of neutrons incident of the sample per cm² (*nvt*). Extensibility is rapidly lost even at quite low dosages. Tensile strength is not changed significantly, but the stress-strain curve is drastically altered as the radiation is increased. The material finally becomes extremely brittle with practically no extensibility. Polyethylene and nylon become so brittle that the corners of the specimens chip off.

The resistance of methylmethacrylate to irradiation is poor. It is noteworthy, however, that the shape of the stress-strain curve is hardly changed. Irradiation alters the state of the material in such a way that failure occurs at decreased stresses and elongations with the points of failure falling along the same curve.

Much higher resistance to irradiation

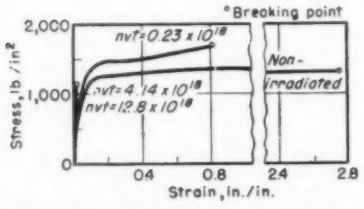


Fig. 3—Stress-strain curves for polyethylene that has been irradiated.

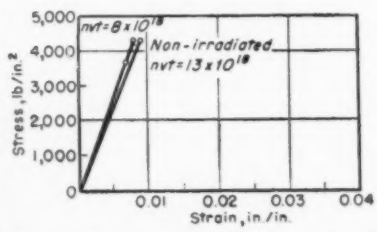
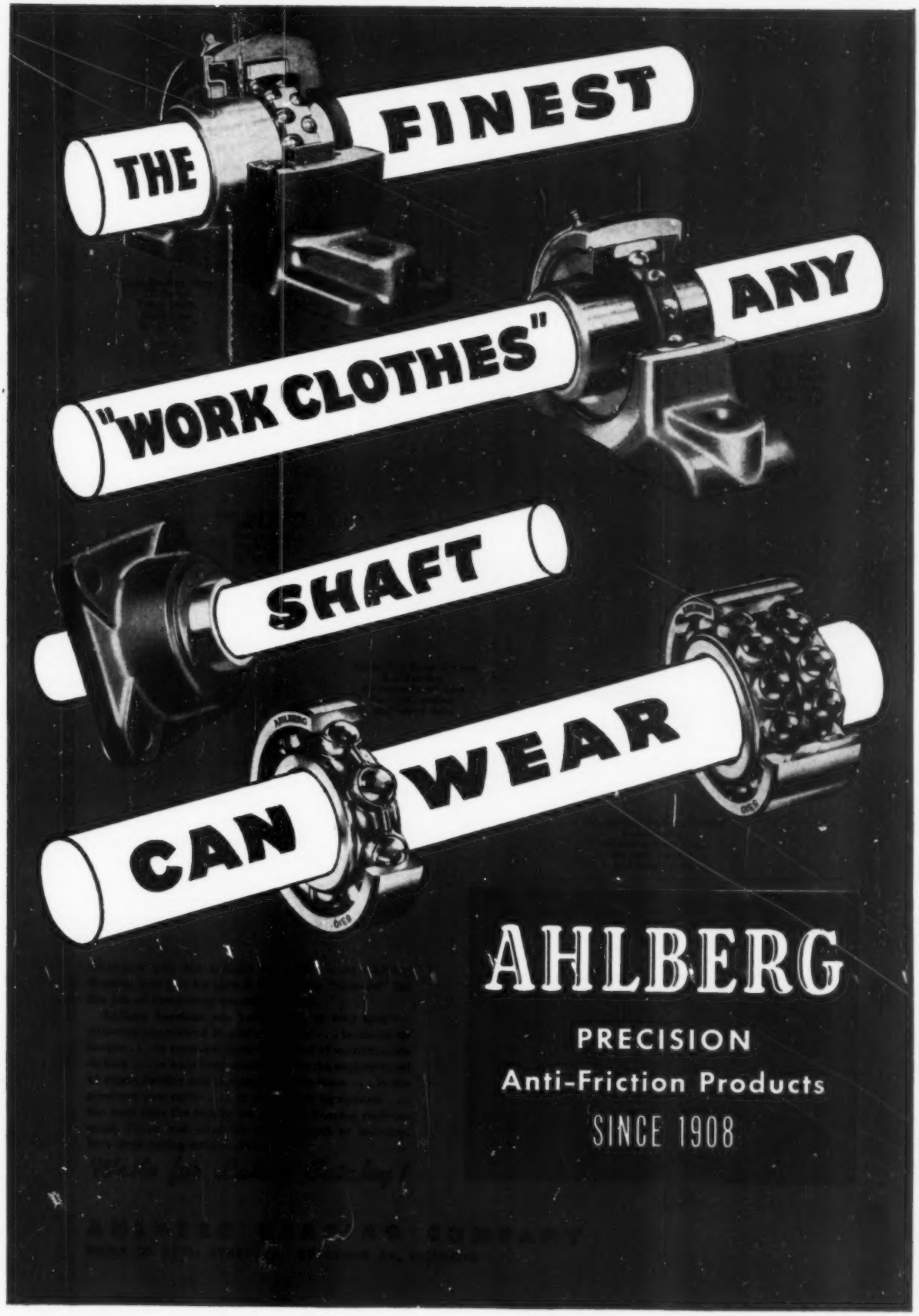


Fig. 4—Stress-strain curves for polystyrene that has been irradiated.


THE FINEST
"WORK CLOTHES" ANY
SHAFT
CAN WEAR
AHLBERG
PRECISION
Anti-Friction Products
SINCE 1908

CROSLEY CUTS ASSEMBLY COST WITH RIVERSIDE "PACKAGED WIRING"

Crosley's "Shelvador" refrigerator line, twice awarded the Fashion Academy Gold Medal for advanced styling, adds to its laurels with this beautiful "Twin Automatic." A medal for smart production engineering might well be awarded too, for Crosley incorporates the use of efficiently designed Riverside electrical components that can be installed quickly, easily, and inexpensively!

We deliver these sub-assemblies completely fabricated, ready for installation. Thus, along with *assembly savings*, Crosley avoids upkeep of the specialized facilities required to *produce* such electrical components, a considerable saving in itself.

The design and production of wiring assemblies is a highly specialized business . . . and a Riverside specialty! Our Engineering Department is devoted solely to solving wiring problems . . . while specialized production equipment and skilled personnel translate its recommendations into efficient, economical "packaged wiring." It will pay *you* to send prints or details of *your* product wiring problem for design suggestions and a firm quotation. There is no obligation.

Attending the Refrigeration and Air Conditioning Exposition? Watch our rubber molding equipment turn out souvenirs while you wait .. see what we're making for appliance manufacturers .. talk over your product wiring problems. Writeit down now—Booth No. 842!

Riverside Manufacturing
AND ELECTRICAL SUPPLY COMPANY

10227 MICHIGAN AVENUE • DEARBORN, MICHIGAN • PHONE Tiffany 6-6800

WIRING HARNESSES AND ASSEMBLIES • CORD SETS • HEATER AND EXTENSION CORDS • ELECTRICAL SWITCHES • RELAYS • MOLDED RUBBER PRODUCTS

is shown by polystyrene, Fig. 4. Only minor changes in elongation and stress are observed at the exposures employed in these experiments. Mineral filled phenolics behave in a very similar way. However, if an organic filler is used, fast deterioration upon irradiation is observed. With a paper base phenolic, for example, drastic reduction in stress and elongation at failures is observed with relatively minor changes in the shapes of the stress-strain curves.

Vacuum Metallizing

Abstracted from "Vacuum Metallizing as a Production Process" by J. Gordon Seiter, Mgr., Vacuum Metallizing Dept., F. J. Stokes Machine Co., Philadelphia, Pa. *The Tool Engineer*, September 1953.

THERE ARE FOUR METHODS of depositing metallic coatings: (1) electroplating, (2) chemical reduction of silver nitrate, (3) electrostatic spraying and (4) vacuum metallizing.

Electroplating will produce a metallic coating of any desired thickness while vacuum metallizing will produce only thin coatings. Chemical reduction of silver nitrate is easily adapted for interior coatings, as for thermos bottles, while vacuum metallizing reaches only those surfaces exposed to the geometrically straight radiation of vaporized molecules. To vacuum-coat most interior surfaces, the vessels must be made into individual vacuum chambers and cannot be handled continuously or in batches. Electrostatic spraying is good for exterior surfaces, but as with electroplating, requires the subject to have electrical polarity.

Vacuum metallizing is less expensive than electroplating and avoids the hazard encountered when handling corrosive and noxious chemicals. It is less expensive than the silver reduction process and does not require the object to be electrically conductive. It will handle a great number of units in batches, or rolled materials continuously. Pieces that require no color and are not to be subjected to abrasion, are finished when they leave the vacuum chamber.

The cost of vacuum metallizing is not affected by the color desired. In other processes, the color is determined by the nature of the metal deposited. Metallized aluminum can be deposited

and a topcoat of lacquer dyed to give the desired metallic color.

Vacuum metallizing cannot replace chrome-plating in every instance, for example, in bumpers and parts that may be subjected to impact shocks and need greater resistance to abrasion. But for other automobile parts, such as radiator grilles, it would serve well.

The Metallizing Process

The metal to be deposited is vaporized by resistance heating. Aluminum is normally deposited by hanging small aluminum staples from stranded tungsten wire filaments. These are connected to the source of electric current through several electrodes running lengthwise through the chamber. The number of filaments is gaged by the amount of metal calculated to be deposited.

The molten aluminum spreads over and wets the strands of tungsten. In its molten state, the aluminum acts as a "getter" to absorb gases and contributes to better vacuum. The temperature is rapidly raised to 1,800 F at which point the aluminum vaporizes in molecular flight to be deposited on the parts.

Some metals when raised to the temperature of the incandescent tungsten filament, do not wet the tungsten and therefore do not adhere long enough to be evaporated. In these cases, the filaments are first electroplated with a heavy coating of the metal to be evaporated.

Other metals and metallic salts, which cannot be hung from filaments, are evaporated from crucibles, normally made by forming tungsten or molybdenum into V-shaped troughs. This setup provides a large surface of evaporating metal and is best suited for processing parts requiring a relatively large amount of metal to be deposited, as in the continuous metallizing of sheet stock or rolls.

Materials and Properties Of Coatings

For decorative purposes, aluminum is commonly used with vacuum metallizing because it is most easily vaporized. This metal has the same color, when deposited by vacuum metallizing, as polished silver, rhodium or chromium. It is cheaper and does not tarnish even when unlacquered. With a topcoat of lacquer it is permanently protected against moderate abrasion

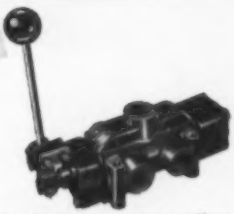
ADEL *Industrial Hydraulic Equipment*

for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

GEAR-TYPE HYDRAULIC PUMPS

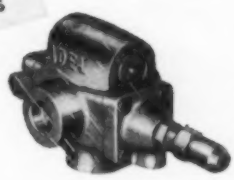
For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

DIRECTIONAL CONTROL VALVES



4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

BY-PASS VALVES



Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.

VOLUME (FLOW) CONTROL VALVES

Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES

2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES

Valves allow free flow in one direction only. Many variations available. 3000 psi.

A FEW SELECT TERRITORIES ARE STILL AVAILABLE TO PROGRESSIVE DISTRIBUTORS OF HYDRAULIC EQUIPMENT. INQUIRIES INVITED.

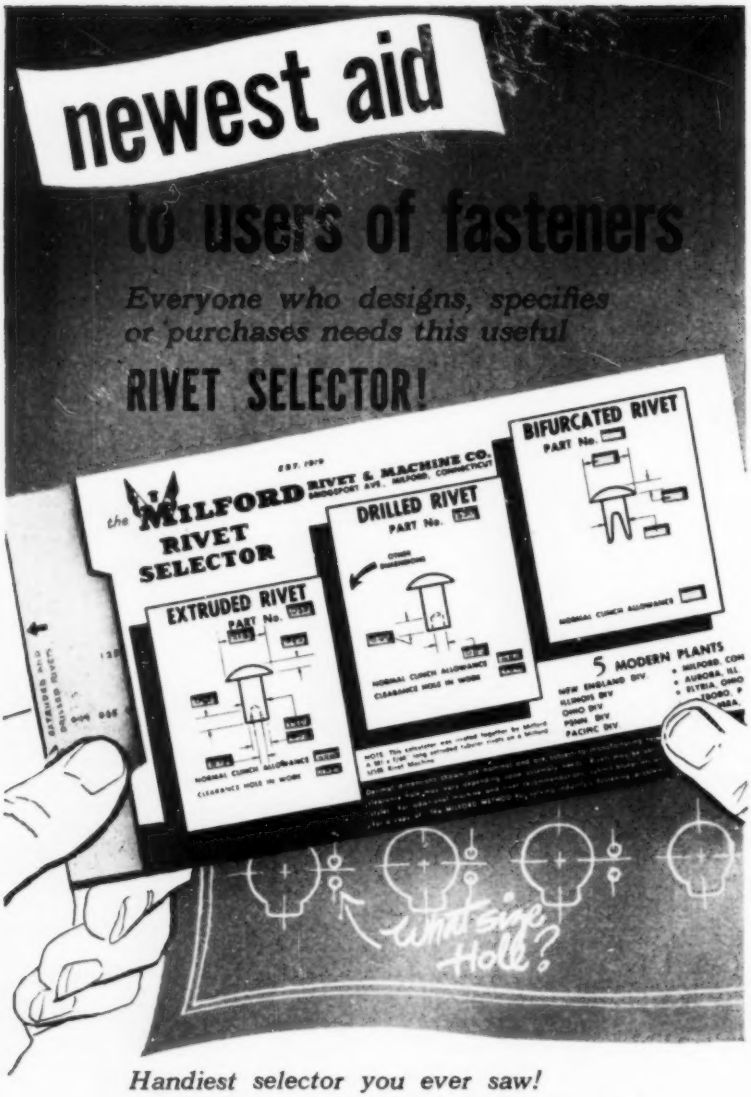
For complete engineering specifications and counsel, Address: ADEL DIVISION—GENERAL METALS CORPORATION, 10767 Van Owen Street, Burbank, California.

ADEL LEADER IN HYDRAULICS

DIVISION OF GENERAL [illegible]PORATION · Burbank, Calif.

Manufacturers of Industrial Hydraulic Valves and Pumps

DISTRIBUTORS: AIR & HYDRAULIC ENGINEERING CO., NEW HAVEN, CONN. • BUSS CHAMBERLIN COMPANY, PORTLAND, OREGON • J. BOYD COATES, PHILADELPHIA, PA. • FRANK T. DONNELLY COMPANY, PITTSBURGH, PA. HASKEL ENGINEERING & SUPPLY CO., SAN FRANCISCO, CALIF. • HASKEL ENGINEERING & SUPPLY CO., GLENDALE, CALIF. • HYDRAULIC BRAKE SUPPLY CO., PHOENIX, ARIZ. • LINCOLN SUPPLY CO., PROVIDENCE, R. I. • SCOTT EQUIPMENT AND ENGINEERING COMPANY, DAYTON, OHIO • H. F. SODERLUND CO., SEATTLE, WASH. • ROBERT TAYLOR & SONS, SALT LAKE CITY, UTAH • WYATT SALES COMPANY, CLEVELAND, OHIO • CORBY SUPPLY COMPANY, ST. LOUIS, MO. • INDUSTRAIL AIR & HYDRAULIC EQUIPMENT CO., DETROIT, MICH.



Handiest selector you ever saw!

Simplifies your job; saves time, speeds choice of right fastener. Easy to read, easy to use, handsomely lithographed in red, white and blue. Shows various tubular and split rivets, part catalog number, normal clinch allowance, size of clearance hole in work and other details to aid your product manufacturing. Sturdily riveted together for lasting use. Write for yours today!

EST. 1919
MILFORD

The name to *RIVET* in your memory for fasteners.

THE MILFORD RIVET & MACHINE COMPANY

877 BRIDGEPORT AVENUE, MILFORD, CONNECTICUT
830 ILLINOIS AVENUE, AURORA, ILLINOIS
1124 WEST RIVER STREET, ELYRIA, OHIO
44 PLATT STREET, HATBORO, PENNSYLVANIA
727 SO. PALM AVENUE, ALHAMBRA, CALIFORNIA

and can be permanently dyed to stimulate any metallic color. Gold and silver are used if the application requires pure metals rather than a simulated color.

Platinum, tungsten, tantalum and molybdenum can be evaporated but are more difficult to process. Nickel and chromium are frequently used despite the high temperatures required to vaporize them. The latter metals usually react with the tungsten filaments, to which the vaporizing material is secured, and create an impure radiation.

Coatings deposited under vacuum seldom exceed five millionths of an inch in thickness and can be controlled to one ten-millionth of an inch. They have a brilliant finish and precisely follow the pattern of the coated object. Vacuum metallizing reproduces surface defects, if any, but these are minimized by the lacquer undercoat applied before metallizing. The brilliant metallized finish does not require the buffing operation characteristic of electroplating. Corrosion resistance of objects thus coated is high when compared with that of electroplated surfaces.

Thickness depends on the length of time the current is held at the vaporization temperature of the depositing metal. Normal time is a flash of 5 or 10 sec after the coating metal has melted and wetted the filament; but it may be sustained for another few seconds to increase the deposit from the normal 3 to 5 millionths of an inch thickness to a practical maximum thickness of about 10 millionths of an inch. Because thickness can be so accurately controlled, it is possible to create surfaces on glass that are nonreflective, partly reflective or opaque and fully reflective to visible light and infrared radiation.

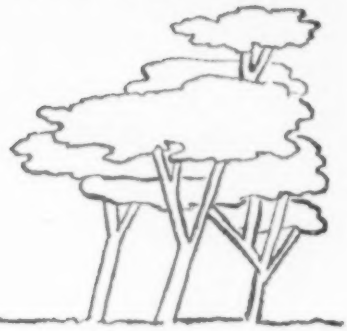
An aluminum film less than 1/300,000 inch thick completely conceals the color of the coated object. Because it effectively hides the color, the process can be used with plastic parts made from scrap material that would otherwise be rejected in ordinary production processes because of poor color.

The coating is fully flexible and adherence is excellent even when applied to cloth, leather, paper, acetate sheets and other materials that are subject to frequent flexing.

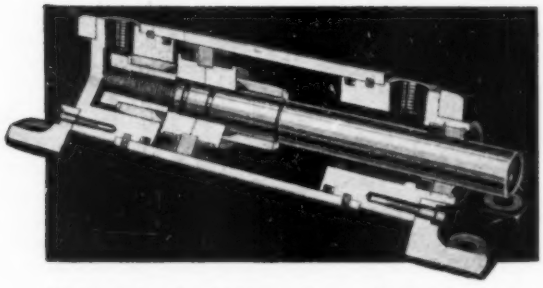
Solve

straight-line motion problems

elevating
lowering
pushing
pulling
tilting
clamping
opening
closing
knock-out operations



with O-M CYLINDERS (air • hydraulic)

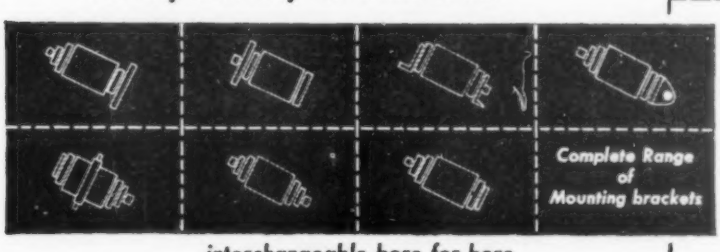


Write today for FREE catalog and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.

14 day delivery on most sizes

From a smooth, delicate push on a testing machine to a rugged thrust on a press application, O-M Cylinders handle all straight-line motion problems with ease and precision. *Special interlocking mechanism* eliminates needless tie rod - end caps . . . saves 1/3 INSTALLATION SPACE. Also assures better alignment, gives O-M the lowest coefficient of friction of *any* cylinder . . . smoother performance at low or high pressure regardless of length of stroke. End plugs tapped for universal mounting. Any one or combination of mounting brackets may be used to install . . . *without disassembling or changing cylinder.* Easily removed, inspected, repaired.

Available in a full range of sizes (1½" to 8" bores) with standard, 2 to 1 or oversize rods. All machined steel with bearing bronze, no castings. Completely interchangeable parts.



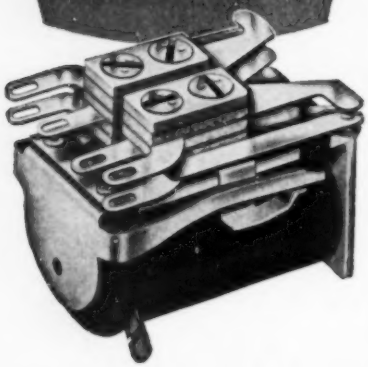
interchangeable bore for bore

ORTMAN-MILLER MACHINE CO.
1218 150th Street, Hammond, Ind.

☐ Please send latest O-M Catalog
☐ Please send Complete Set of Templates

Name..... Position.....
Company.....
Address.....
City..... Zone.... State.....

115 million cycles without a breakdown!



Torture Test Proves COMAR RELAYS are Tough

Illustration shows a typical Comar Telephone Type "TM" Relay recently subjected to exhaustive tests by a Comar user. Results: 115 million cycles without a breakdown!

Comar relays stand up under severest operating conditions. They are engineered to far exceed normal performance and circuit requirements. Precision workmanship and top quality is your assurance of dependable operation. Comar specializes in relays custom-engineered to fit your needs. Send specifications for our recommendations, no obligation.

Write For Free Catalog

COMAR
ELECTRIC COMPANY
3349 Addison St. • Chicago 18, Illinois

Relays • Transformers • Solenoids
Switches • Coils • Hermetic Sealing

• PROJECT CHURCHY is the name assigned to a scientific expedition that will make cosmic ray studies off the Galapagos Islands. Sponsored by the Office of Naval Research, the group will gather data concerning high energy (in excess of 13 billion electron volts) primary cosmic radiation near the geomagnetic equator. Only very high energy particles reach the earth at this point because the earth's magnetic field deflects less potent particles.

• JULIUS J. HARWOOD has been appointed Head of the Metallurgy Branch of the Office of Naval Research, replacing Dr. O. T. Marzke who has returned to the Naval Research Laboratory as Associate Director.

• THIRD MAJOR COMPANY to announce commercial production of transistors*, General Electric Company says their all-welded unit has been designed to permit automatic mass production of a hermetically sealed device that eliminates aging effects caused by moisture and trapped solder flux fumes. First shipments are scheduled for this month.

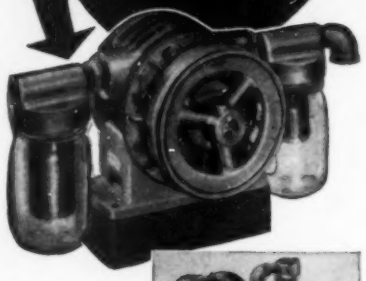
• LEHIGH UNIVERSITY has ordered the largest universal testing machine—57 ft tall with a capacity of 5,000,000 lb—for their new Fritz Engineering Laboratory. Baldwin-Lima-Hamilton Corporation will build the hydraulic machine scheduled for delivery in February 1955.

• U. S. NAVY's Bureau of Ships is studying methods of making warships more habitable. Their first experiment on the U. S. Meredith, a 2,200 ton destroyer, attempted to improve living conditions by taking into consideration factors such as temperature, ventilation, noise, vibration and odor. Industrial designers, hired as consultants, helped make changes like these: wider use of plastic materials for furniture coverings, increased use of aluminum for furniture structures, fluorescent lighting instead of incandescent, and improved storage facilities.

• THERE ARE PROSPECTS for an immediate shortage of toluol, an important constituent of aviation gasoline and paints. According to the National Paint, Varnish and Lacquer Associa-

** The other two: Raytheon Mfg. Co., and Sylvania Electric Products, Inc.*

Get absolutely
OIL-FREE AIR
with GAST rotary
OIL-LESS AIR PUMPS



Above — Oil-less Model 1550 — 8 to 10 C.F.M.
Right — Oil-less Model 3040, end plate removed. From 17 to 24 C.F.M.

Three things about these pumps are outstanding:

FIRST — They run *entirely without oil* in the pumping chamber. Four carbon vanes in rotor lubricate themselves — through thousands of hours of operation. Ball bearings are greased and sealed for life. You can *forget* oiling problems!

SECOND — They completely eliminate oil-mist in the air delivered. Used for *both* vacuum and pressure they *can't* contaminate your product or material with oil droplets.

THIRD — They're built with traditional Gast precision — for years of high performance and dependability.

IF THESE QUALITIES offer solutions to your original equipment problems, write Gast. Oil-less models from 10 to 20 inches vacuum — 3 to 10 lbs. pressure — 3.5 to 24 C.F.M.

See our CATALOG in SWEET'S FILE

Write for new Data Sheet on Oil-less Pumps, showing 3 types and rating tables.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY
AIR MOTORS • COMPRESSORS • VACUUM PUMPS
(TO THREE H.P.) (TO 50 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 139 Hinkley St., Benton Harbor, Mich.

tion, only increasing production has averted a shortage prior to this, but now, one of the major producers must shut down for repairs and new capacity, expected this fall, has been delayed. Ample supplies are expected by the beginning of 1954, when new plants start production.

NON-FERROUS FILM FOR GALVANIZING

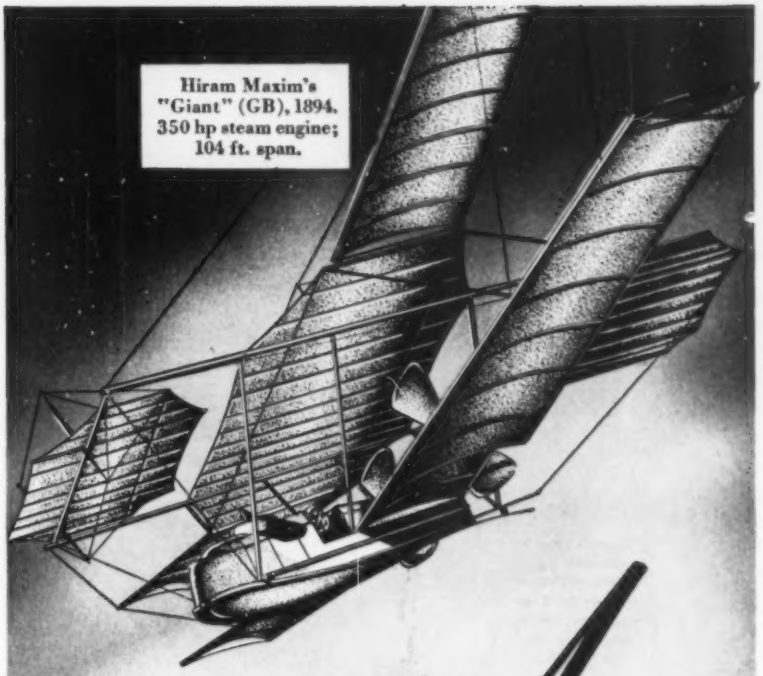
THIN NON-FERROUS METAL FILMS, plated on strip steel, may be one way to improve the process of hot galvanizing strip says Allen T. Baldwin, of the Hanson-Van Winkle-Munning Company.

According to metallurgist Baldwin, the film protects the treated surfaces after they have been pickled clean by ordinary methods—it can retard and possibly prevent the formation of any iron oxide that would interfere with the alloying of molten zinc to the steel surface.

ROBOT SCANNER FOR BEARINGS

TURBINE BEARINGS on the U. S. Navy's giant aircraft carrier, the U.S.S. Forrestal, will be watched by an automatic electronic temperature monitor. If temperatures at any one of 40 critical locations reaches an unsafe level, the scanner, built by Minneapolis-Honeywell Regulator Company, will sound an alarm, pin pointing the trouble spot. The device eliminates the current practice of manual inspection of bearing thermometers or manual analysis of recorded data.

Object of the device is to guarantee against bearing burn-outs, particularly when the ship is in combat and turbines are subject to emergency loadings. To do this, 40 thermocouples are imbedded in critical locations and linked to the scanner. Operating on a continuous basis, the device automatically reviews temperatures at all 40 points every ten seconds—six complete checks every minute. When a hot bearing is detected, the device sounds a warning to alert the engine room crew. A crew member can determine the exact temperature of the overheated bearing, and make necessary adjustments before the localized heat is sufficient to cause a burnout.



...out of this came Aviation

The manufacturing facilities of IGW at Indianapolis

An industry whose tremendous growth has forced the continued expansion of the manufacturing facilities of many companies to feed this great industry's carnivorous appetite for production.

Indiana Gear Works is such a company—we began to produce precision parts for the aviation industry in 1933.

Today, twenty years later, we find ourselves continuing to increase our physical plant in order to gain the production capacity we need to consistently produce quality precision parts and assemblies.

INDIANA GEAR

INDIANA GEAR WORKS, INC. • INDIANAPOLIS 7, INDIANA

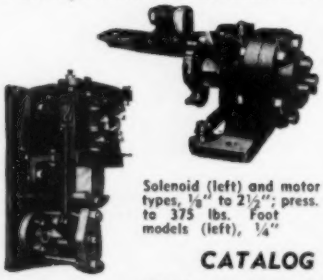
Let Doctor "E" Solve YOUR Lubrication Problems Too . . .
with Electrofilm
DRY FILM LUBRICATION
AIRCRAFT
TRANSPORTATION MAINT.
BUSINESS MACHINES
MACHINERY MAINT.
SPORTING GOODS
PIPE LINES
DIESEL ENGINES
AUTOMOTIVE MAINT.
1001 INDUSTRIES
RECOMMENDED
. . . where ordinary lubrication is not adequate due to extremely high or low temperature, solvents, inaccessibility, dirt, pressure, etc.
FACILITIES IN PRINCIPAL CITIES
SAVE MONEY . . . . . Write for Doctor E's FREE Bulletin of case histories and technical data

Electrofilm, Inc. Dept. J, P.O. Box 106, North Hollywood, Calif.

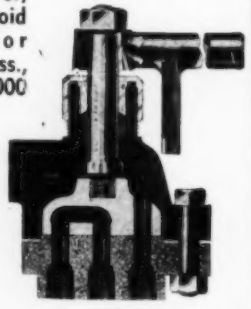
Large Processor Chooses

Nicholson Valves for LONG WEAR

A large rubber firm reports that Nicholson cylinder control valves recently completed 10 years of constant use, without servicing, on an operation which had proved too much for other tested units. This report further confirms that Nicholson valves, with their specially treated hard seats and non-corrosive lapping flat discs, become tighter with use. For air, gas, oil, steam, water in lever, foot solenoid and motor types. Press., 300 to 5,000 lbs.



Solenoid (left) and motor types, ⅛" to 2½"; press. to 375 lbs. Foot models (left), ¼" to 1½"; press. to 300 lbs. Lever models (right), ¼" to 2½"; press. to 5000 lbs.



CATALOG 552

200 Oregon Street, Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

OUR READERS SAY

Formula For Estimating Wire Size Is Revived

To the Editor:

In the Electrical World magazine of 48 years ago (Sept. 1905), I proposed an approximate formula for connecting wire size number (A.W.G.) with its circular mils area for copper wire. A month thereafter this was combined with another formula, transforming it so greatly that it was hardly recognizable.

I think that it is well worth being revived, for it is easily remembered, quick, but a little tricky, since the signs of the logarithms must be preserved. It needs no wire tables, only a slide rule:

$$n = 36.99 + 10 \log \frac{v}{di}$$

in which n is the gage number; v the voltage drop; d the distance in feet one way; and i the amperes. Gage number is based on voltage drop and not on the capacity of the wire. Take 30 amp, 500 ft, 10 volts drop.

Let

$$y = \frac{v}{di} = \frac{10}{500 \times 30}$$

$$= \frac{1}{1{,}500} = 0.000667$$

(Note: $\log 1{,}500 = 3.176$)

$$\log y = \log 0.000667$$
$$= -4 + 0.824 = -3.176$$
$$10 \times \log y = -31.76$$
$$n = 36.99 - 31.76 = 5.23$$

This is between #5 and #6. As a check from the tables, #5 gives 9.4 volts, #6 gives 12 volts, with 10 volts required.

Second example for larger wires. Take: $d = 200$, $i = 500$, $v = 10$

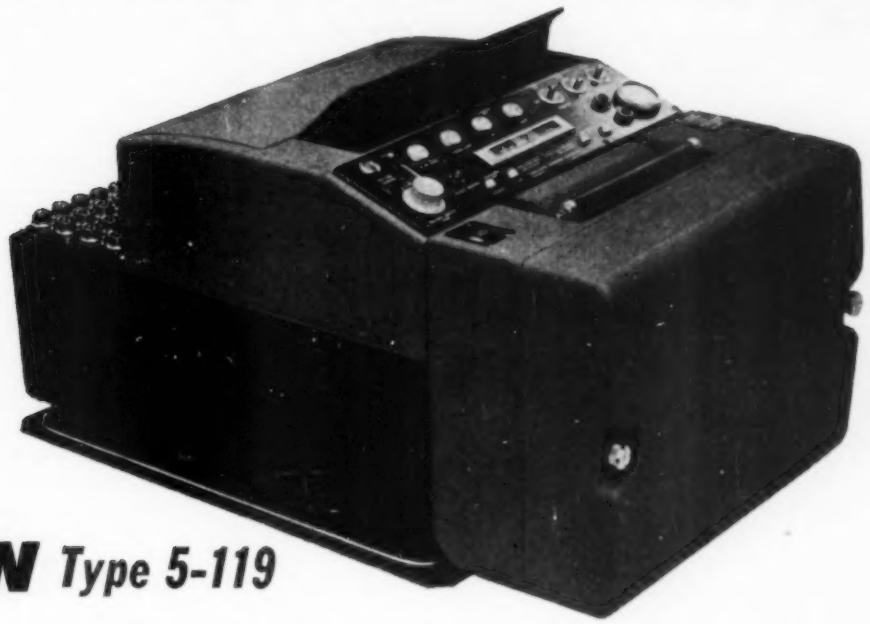
$$y = \frac{v}{di} = \frac{1}{10{,}000}$$

$$\log y = -4$$
$$10 \log y = -40$$

4/0, 3/0, 2/0, 1/0 being -3, -2, -1, 0 respectively.

$n = 36.99 - 40 = -3.01$; close to 4/0 wire, which has 211,600 cm, while the ordinary

YOU *helped create this superior Recording Oscillograph*



NEW *Type 5-119*

CONSOLIDATED's new Type 5-119 Oscillograph was designed and built to customer specifications. Many major users were interviewed by our design engineers to determine the features desired in a "perfect" instrument. Foremost demand was for great dependability. Second need indicated was for high trace capacity.

Dependability is achieved by extensive warning and test circuits and by reserve lamps which assure continuous recording in the event of lamp burn-out. Indicators warn immediately of any condition which could cause data loss, while additional circuits permit quick testing of the warning system. Design of the instrument assures reliable operation under the most rigorous environmental conditions.

Standard models provide either 36 or 50 traces. Consolidated's new Series 7-300 Galvanometers provide frequency response flat to 3000 cps. Standard record width of 12″ greatly simplifies record interpretation. Only after several prototypes were successfully tested under actual field conditions did we go into production on the 5-119—the new recording oscillograph leader. Write for Bulletin CEC 1536-X2.

SPECIFICATIONS

TRACE CAPACITY	36 or 50-trace models available
TRACE IDENTIFICATION	repeated, sequential trace breaks
RECORD WIDTH	12″ standard; narrower widths adaptable
RECORD MAGAZINE	removable, integral type; holds 250′ paper or film
RECORD SPEEDS	0.10 to 100 inches per sec. through quick-change gears, instantaneous switch-actuated, 10:1 speed jump
SCANNING SYSTEM	ground-glass screen and adjustable motor-driven polygon mirror; timing lines show on viewing screen
REMOTE OPERATION	accessory control unit with all essential controls & indicators
TIMING PROVISIONS	0.10 and/or 0.01 sec. lines photographed across record
EVENT NUMBERING	high-speed flash system operates as rapidly as one number per sec.
POWER REQUIREMENTS	115 volt, 60 cycle and 26 volt d-c models
INPUT PROVISIONS	all connectors on one rear deck; individual galvanometer plugs
CONTROL PANEL	all controls and indicators on single panel
ACCESSIBILITY	all adjustments can be made from one surface

The 5-119 can be panel mounted vertically with special shockmounts.

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

analytical instruments for science and industry

Recording Oscillographs

The Type 5-119 is the newest of 7 Consolidated Oscillographs ranging from 9 to 50 channel capacity. These versatile instruments simultaneously record any physical phenomena that can be transformed into electrical impulses. All measurements are obtained in clear, permanent form during the same operational cycle for future detailed analysis.

Pick 'DIAMOND H' RELAYS

Shown Actual Size

...FOR HIGHER VIBRATION RESISTANCE

Vibration resistance range of "Diamond H" Series R Relays has been more than doubled, extending now from 0 to well over 1,000 cycles per second at 15 "G's."

Continuing engineering developments such as this are constantly broadening the adaptability of Series R Relays for a wide variety of applications . . . guided missiles, jet aircraft, fire control and detection, radar, communications, high speed camera, geophysical and computer apparatus . . . and similar applications requiring positive operation under critical conditions.

Hermetically sealed, miniature aircraft relays, Series R devices are basically 4PDT, but are also available in DPDT and 4PDT with two independent coils, either or both of which will operate the unit. Available with all standard mounting arrangements, including ceramic socket for interchangeability. Their design permits unusually compact grouping and provides a firm bond between relay and chassis. See us for special arrangements.

In their field still the smallest and lightest, (1.6 cu. in., 3.76 oz.) combining highest operating shock resistance (to 50 "G" and higher), widest temperature range (−65° to +200° C.) and greatest ability to break high currents and high voltages, Series R Relays consistently operate over 400,000 cycles without failure at 5 A. and go 3,500 or more under 30 A. at 30 V., D.C., resistive. They carry voltages up to 300 D.C. at 4/10 A. for more than 400,000 cycles. With low contact loading, life expectancy is 10 million cycles or better.

Operating time is 10 ms. or less; drop out time 3 ms. or less. Coil resistances up to 35,000 ohms are standard; to 50,000 ohms available for special units. Sensitivity approaches 100 mw. at 30 "G" operational shock resistance. Inter-electrode capacitance is less than 5 mmf. contacts to case—less than 2½mmf. between contacts, even with plug-in type relay and socket.

Designed to meet all requirements of USAF Spec. MIL-R-5757B, they far surpass many. Bulletin R-150, giving basic performance data under varying conditions, is yours on request. Our engineers are prepared to work with you to develop variations to meet your specific requirements. Tell us your needs.

THE HART MANUFACTURING COMPANY

206 Bartholomew Avenue • Hartford, Connecticut

solution calls for 216,000 cm.

The American Wire Gage (B&S) is a consistent gage of sizes that may be succinctly stated:

$d_m = 460r^{n+3}$, in which
d_m is the wire diameter in mils
r is the ratio, equal to 89,053
n is the gage number

However good it is, its devisers would have made it still better had they foreseen that if $r^6 = \frac{1}{2}$ instead of 0.49873, a great simplification would follow, namely: for every numerical increase of 6 sizes, the diameter is halved. On this is based the approximations. From the foregoing it will be seen also that for each 10 numerical increase in gage numbers, the resistance will be increased 10 times.

In *Product Engineering*, August 1946, page 161, a complete compact graphical representation gives for each gage number of the A.W.G. its diameter, circular mils, weight, and resistance.

—CARL P. NACHOD
Nachod & U. S. Signal Co., Inc.

To the Editor:

In your April 1953 issue of *Product Engineering*, J. O. Almen states in his article on "Brittle Structural Failures With Emphasis on Welded Ships" that he goes to the scrap pile to study failures. Well said. As manufacturers, while we do not go that far, we urge users of our products to return them to us periodically for examination and overhauling even before they break down. Such a practical service covers much, and benefits the user more than he may realize. One railroad thus regularly returns their track instruments, and the study of their used condition enables us to improve the design, or use more suitable materials.

It is self evident that a user will continue to buy a trouble-free device.

—CARL P. NACHOD
Nachod & U. S. Signal Co., Inc.

The Story Will Be Forthcoming

To the Editor:

At the present time in our organization there are various product numbering or identification systems in use. The Engineering Department uses one system for their drawings, the Sales

Department uses another for their identification of our products, and our Stores Department employs still a third system in certain cases.

A decision has been made to develop and put into effect a plant-wide product identification system. Before doing this, we would like to familiarize ourselves with such a single plant-wide numbering systems of products and parts thereof. The thought occurs to me that you may be able to refer us to articles or texts dealing with the subject and we shall appreciate any such reference you are able to submit to us.

—J. A. STEIN
Chief Engineer
Bacharach Industrial Instrument Co.

Ed—We have had many requests for information on numbering systems. A comprehensive article on this subject is now in production and will appear in an early issue of *Product Engineering*.

To the Editor:

Article Worth Waiting For

After passing through many hands, the May 1953 issue of *Product Engineering* has come to my desk. I should like to compliment you particularly on the article "Consulting Development Groups", by A. W. Richards. This is as clear a presentation of the basic problems as I have seen. If reprints are available, I would appreciate two copies.

—WILLIAM J. HOLDEN
Redwood City, Calif.

Product Development

To the Editor:

In a recent issue of *Product Engineering* (June 1953) there are many interesting articles on design, development and research. There are also comments about the necessity for more research, elemental and applied.

For the past twenty five years I have been engaged as a designer and inventor of design plans and machines and find at the present time that the individual inventor is so discriminated against that he is being forced into extinction.

Among the things I have designed are a polaroid ski goggle (for which I netted $130.00), a computing gun

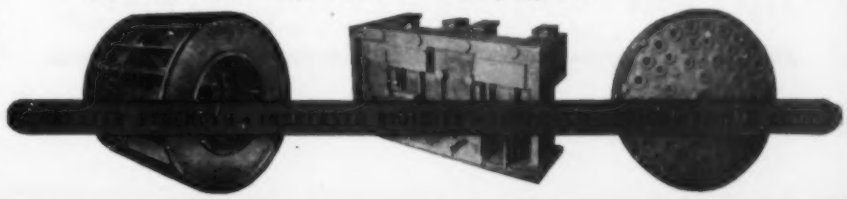
WELDMENTS
CAN SAVE YOU MONEY!

Acme weldments are replacing castings for leading machinery and equipment manufacturers everywhere because they do a better job at lower cost. Experienced Acme engineers at work with Acme's complete fabrication facilities can give *you* these same advantages . . . Acme's new 24-page, illustrated booklet shows you why. ***The Facts about Weldments and Castings*** tells you what you should know about their relative strength, rigidity, vibration, design flexibility, and cost . . . facts to help you specify and save. And it's yours for the asking . . .

ACME
TANK and WELDING
DIVISION of THE UNITED TOOL & DIE CO.
1089 New Britain Ave. • West Hartford 10, Conn.

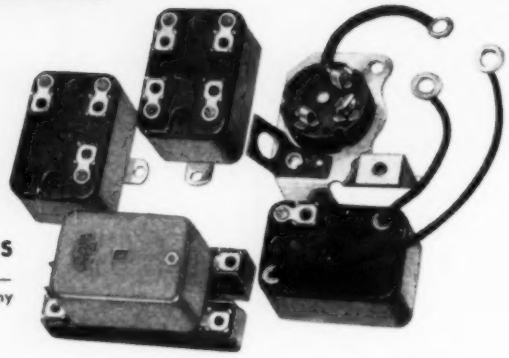
- A.S.M.E. Qualified Welders • National Board Approved
- Hartford Steam Boiler Inspection Service • A.P.I. Approved
- Underwriters Label and Inspection Service • Navy Approved

Write for yours TODAY!

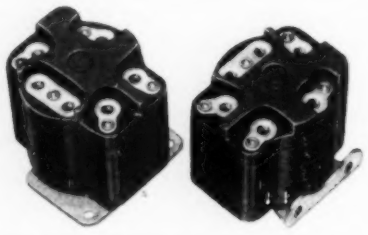


A COMPLETE LINE—
Designed to Your Requirements

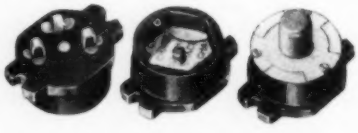
R-B-M
MOTOR STARTING RELAYS AND OVERLOAD PROTECTORS



SERIES RELAYS
Balanced armature—Can be mounted in any position.



POTENTIAL RELAYS
Precision snap-action contacts. Convenient terminal board wiring. Totally enclosed.



OVERLOAD PROTECTORS
Patented bi-metal snap-action—inherent protection. Large solder terminals. Manual and automatic.

VISIT BOOTH 929
8TH ALL-INDUSTRY REFRIGERATION AND AIR CONDITIONING EXPOSITION • NOVEMBER 9-12 • CLEVELAND

R-B-M DIVISION
ESSEX WIRE CORPORATION
Logansport, Indiana

Controls for Electronic, Refrigeration, Industrial, Appliance, Communication and Automotive Industries

RBM

sight of extremely simple design (it worked) and a number of metal forming machines.

At present I am wholly occupied with a very simple device to make circles of tube, strip and various sections. It is far more versatile and lower priced than any other machine on the market and is used for jet engine spacer rings, by a number of companies for radar contact rings, for watch bracelets, for pipe flanges and for weld testing.

However, I am on the verge of bankruptcy in my beautiful small shop where we build the machines. The first reason is that risk capital is not available, as if one wins with it the government takes it.

Only having one employee, the government would class my shop as a personal holding company. Therefore, royalties have to be taken individually, taxed as such, and therefore losses in development work cannot be used as a tax deduction.

Large corporations can deduct their development work from taxes. If they buy from me as a development man they cannot. (In spite of this the individual inventor can usually produce results more cheaply than the large corporation).

You mention in the June issue that 50 percent of the patents are granted to individuals. I am one of the more fortunate of these individuals as I am a first class toolmaker and can sell what I make, but under the present situation in this country I cannot even make a living. —PETER KILHAM
Kilham Engineering Inc.

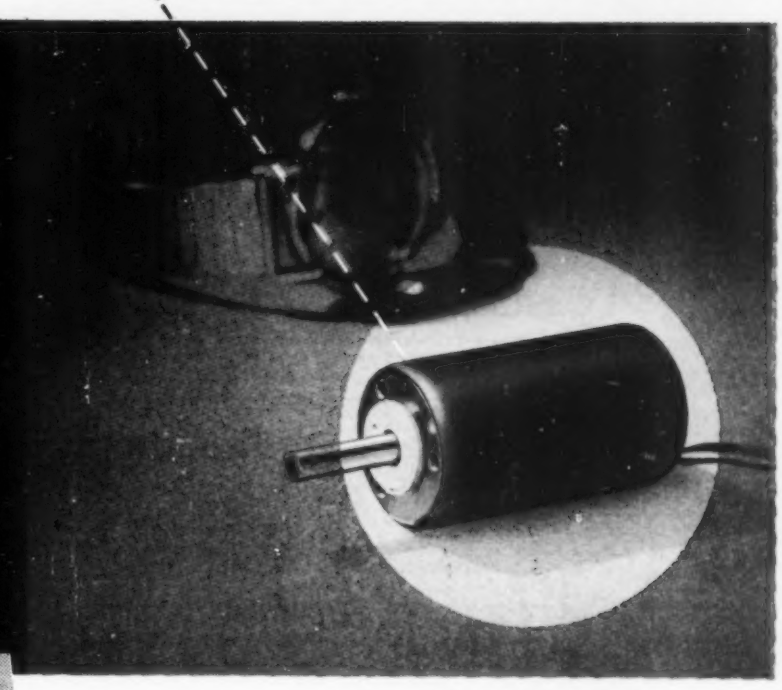
Ed—As you stated, risk capital is hard to get because it is impossible for individuals or companies to keep enough of their profits. To be able to deduct your losses, I would suggest that you get a smart tax expert or accountant. Here are some "off the cuff" comments from the McGraw-Hill Economics Department on this situation:

1. Risk capital is a loose term for money that someone invents in a new and risky business, usually a small business. The man who starts the business usually doesn't have enough savings of his own to develop it very far, and banks won't loan him more than a certain amount unless he or his friends put in more on a permanent basis. So he starts looking for

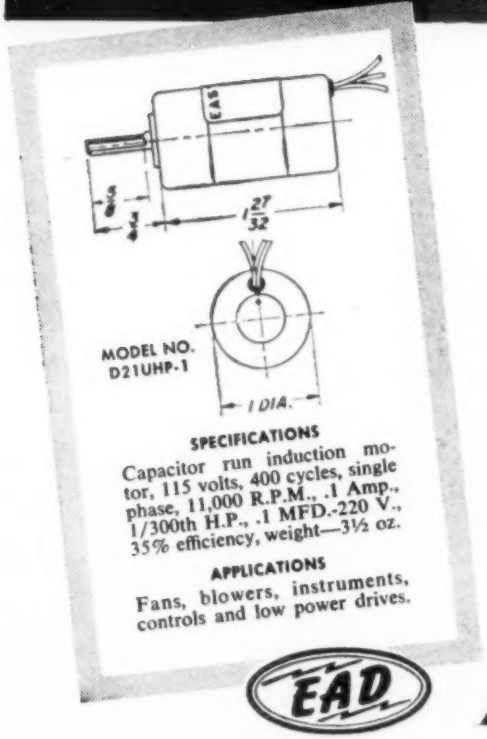
"miniaturized"

FOR MAXIMUM EFFICIENCY

new versatile 1" motor



MODEL NO. D21UHP-1 (ACTUAL SIZE)



SPECIFICATIONS

Capacitor run induction motor, 115 volts, 400 cycles, single phase, 11,000 R.P.M., .1 Amp., 1/300th H.P., .1 MFD.-220 V., 35% efficiency, weight—3½ oz.

APPLICATIONS

Fans, blowers, instruments, controls and low power drives.

Another outstanding EAD contribution to the miniaturization program is this extremely small, precision motor. Engineered for *long life and high efficiency*, it is especially designed for operation in confined areas where minimum size and weight is essential.

Units are available in this small frame size for 400 cycle or variable frequency operation, with 400 cycle power ratings ranging up to approximately 1/100 H.P. Modifications include high ambient and high altitude versions as well as servo, synchronous and gear motors.

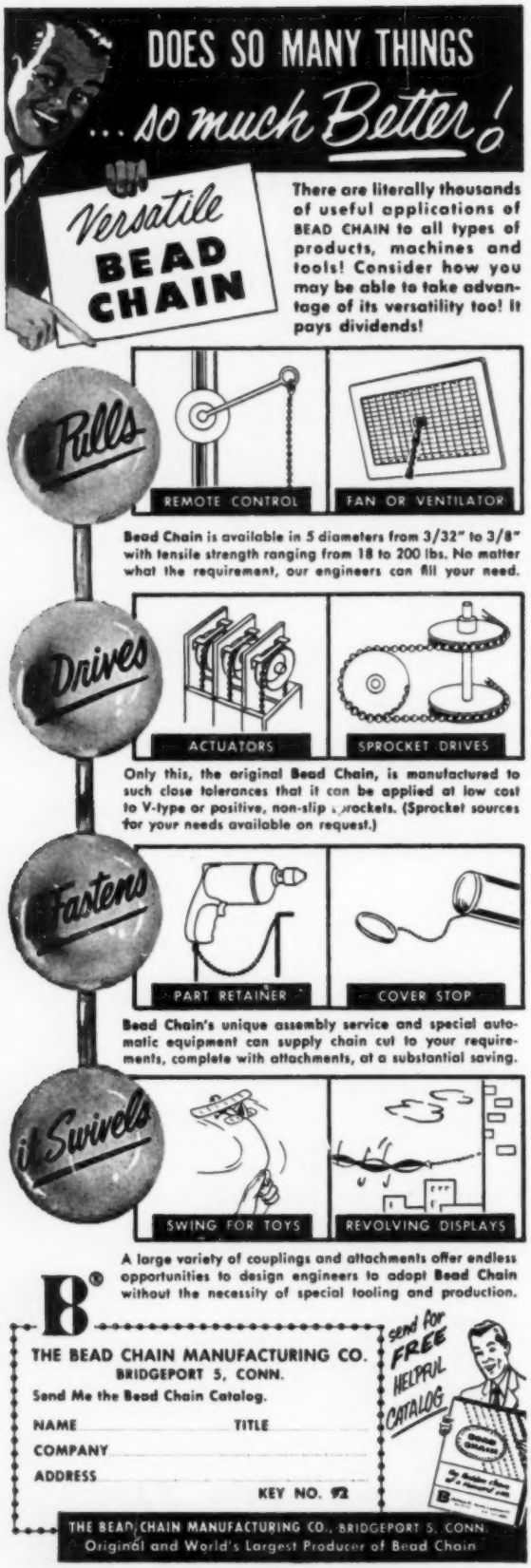
400 CYCLE OPERATING CHARACTERISTICS

APPROXIMATE R.P.M.	7,000	10,500	21,000
PHASES	1,2	1,2,3	1,2,3
INPUT VOLTAGE (MAXIMUM)	115	115	115

EAD

EASTERN AIR DEVICES, INC.

585 DEAN ST., BROOKLYN 17, NEW YORK


DOES SO MANY THINGS
...so much Better!
Versatile BEAD CHAIN
There are literally thousands of useful applications of BEAD CHAIN to all types of products, machines and tools! Consider how you may be able to take advantage of its versatility too! It pays dividends!
Pulls
REMOTE CONTROL
FAN OR VENTILATOR
Bead Chain is available in 5 diameters from 3/32" to 3/8" with tensile strength ranging from 18 to 200 lbs. No matter what the requirement, our engineers can fill your need.
Drives
ACTUATORS
SPROCKET DRIVES
Only this, the original Bead Chain, is manufactured to such close tolerances that it can be applied at low cost to V-type or positive, non-slip sprockets. (Sprocket sources for your needs available on request.)
Fastens
PART RETAINER
COVER STOP
Bead Chain's unique assembly service and special automatic equipment can supply chain cut to your requirements, complete with attachments, at a substantial saving.
It Swivels
SWING FOR TOYS
REVOLVING DISPLAYS
A large variety of couplings and attachments offer endless opportunities to design engineers to adopt Bead Chain without the necessity of special tooling and production.
B®
THE BEAD CHAIN MANUFACTURING CO.
BRIDGEPORT 5, CONN.
Send Me the Bead Chain Catalog.
NAME TITLE
COMPANY
ADDRESS
KEY NO. 92
Send for FREE HELPFUL CATALOG
THE BEAD CHAIN MANUFACTURING CO., BRIDGEPORT 5, CONN.
Original and World's Largest Producer of Bead Chain

someone to put in this additional "risk capital."

This kind of money is pretty hard to get. The small company doesn't have the kind of standing it would need to sell stocks or bonds to the public or to big investing institutions. The only chance is to get a wealthy individual or group of individuals that the owner, or his friends, or his bank, thinks will take a chance with him. Wealthy individuals often hesitate, as Mr. Kilham notes, because today's taxes are so high that the return after taxes does not appear to be worth the risk. Safer investments often yield nearly as much after taxes.

In this situation, many small companies are unable to get additional capital to expand and wind up by selling out to big companies. However, it would be a mistake to say that all small companies are pushed to the wall in this way. A recent survey by the Harvard Business School showed that a great deal of risk capital is being invested in small companies by wealthy individuals who have found ways (usually by making capital gains) to avoid the high tax rates. There just isn't enough to go around.

The biggest step so far taken to meet the special need for small companies is the formation of special risk capital companies to invest in such situations. The best known is the American Research and Development Corporation of Boston. They have financed a number of scientific developments through to the commercial stage, including high vacuum distillation (for blood plasma, frozen orange juice, etc.) and atomic tracers (for medical and industrial use). Up to now these outfits have not found the machinery field as attractive for investment as the chemical, electronic and other highly scientific fields. Once again, there's not enough money to go around. It's just a start on a very tough situation.

2. Sales of inventions, or royalties on inventions by a professional designer or inventor are ordinary income for tax purposes and cannot be spread out or treated as capital gains. This applies either to an individual or a corporation. However, if he owns a small corporation, he can sell the stock (i.e. the corporation and its ownership of the invention) and take a capital gain on that.

3. Product design expenses are op-

erating expenses for tax purposes no matter who does it. The purchase of a patent from an outsider (i.e. the purchase of a previously patented design) is considered to be the purchase of an asset. This can be amortized over future years but is not an operating expense for tax purposes in the year it is purchased.

4. Machinery designed and installed in the company's own shop is a capital expenditure and not tax deductible.

5. Losses on product development, and all other operating expenses, are deductible for tax purposes. Only capital losses (i.e. if the inventor sold one of his own shop fixtures at a loss) are not deductible.

Foamed Plastics

To the Editor:

We are interested to read the contribution of Mr. H. J. Stark concerning properties and characteristics of foamed plastic materials, in the April issue of your Journal *Product Engineering*.

As we are intimately associated with the development of Expanded Rubber and Plastic materials, we should like to make this article available to several members of our senior staff, and are therefore writing to inquire whether it would be possible for us to purchase four reprints of this

—A. COOPER
Expanded Rubber Co., Ltd.
Croydon, England

New System for Machine Fits

To the Editor:

It appears that many engineers, draftsmen, tool designers, production directors, engineering professors and students are not aware of the opportunity for encouraging progress which is available in the field of tolerances and fits for machine components.

In 1947 the American Standards Association published standard ASA B4.1-1947 as Part I of a new American-British-Canadian standard. This included definitions, preferred basic sizes and a table of values for use in tolerances and allowances. It did not offer any suggestions on grouping these tolerances and allowances into specific fits. In fact, the most recent

to rotate sludge rakes at exacting speeds in Process Clarifiers

WINSMITH SPEED REDUCERS

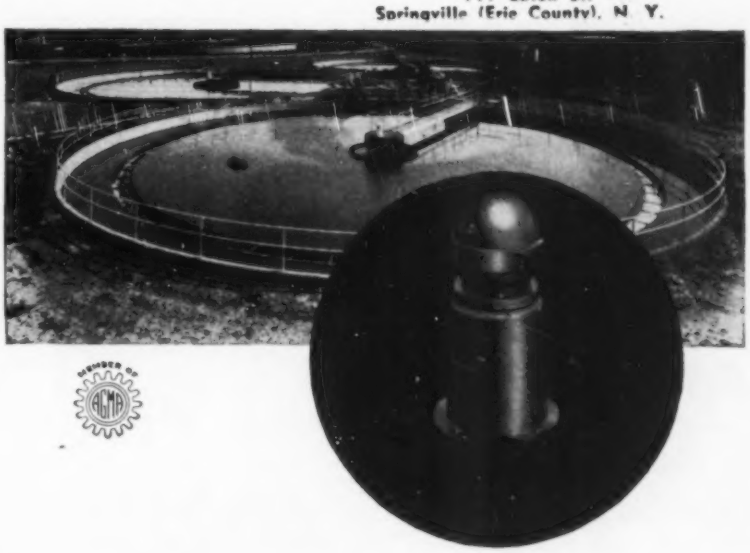
Under varying sludge loads, rake arms of this Process Clarifier sweep the 100 ft. diameter settling basin at speeds most ideal for sewage and water treatment. Lineal velocity of 10 ft. per minute must not be exceeded. Centered in the drive mechanism, powered by a 3/4 hp motor, a Winsmith Differential Gear Speed Reducer rotates the rakes at a consistent 1/30 rpm.

"The Winsmith unit was selected primarily for its high available reductions within a compact case . . . quiet operation, reliability," says Process Engineers, Inc. "Some of our installations . . . have been operating continuously over the last four years without shutdown for other than normal maintenance."

Rugged dependability and compactness have led numerous manufacturers to think of Winsmith *first* when they *first* think of speed reducers. It's the most complete, fully standardized line of worm, helical and differential units within the range of 1/100 to 85 hp.

Request Catalog 148 for details.

WINSMITH, INC.
111 Eaton St.
Springville (Erie County), N. Y.



Who could blame a person for having murder in his heart. After laboring over a drawing for hours, suddenly there's an unexpected blob of ink, and in a flash the drawing is ruined.

That's why it pays to specify Arkwright Tracing Cloth. Careful manufacture assures a working surface free of heavy threads, pinholes, and other imperfections that can lead your pen to disaster.

Arkwright Tracing Cloth is fortified, too, to take all the erasing you'll normally ever give it. Erase . . . and ink again. Lines will still come out sharp and clear — without "feathering". That's why Arkwright Tracing Cloth is ideal for good, readable blueprints.

Want to be convinced? Write for a free sample. Arkwright Tracing Cloth will convince you, just as it has thousands of others, it's truly "America's Standard". Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR [illegible] YEARS

approved American Standard for [illegible]s was in 1925, although a Draft War Specification was made in 1945. The 1925 standard has been extensively used, as written, or as a basis for individual company standards, but its scope was very limited and had no coordination with other standards. Various attempts have been made to bring the subject up to date, and currently a proposal is being considered by the American Standards Committee B4 on fits and tolerances which, if accepted, would result in interchangeability, between fits designed in the United Kingdom, Canada and the U. S. A. Even the best system of fits and tolerances does not cover all conditions, but a system such as the proposed American-British-Canadian (ABC System) does cover a large field of common fits while giving a logical guide and starting point for special fits. Even for ordinary fits, where conditions do not warrant the use of tolerance figures carried to several decimal places, the tabled figures may be rounded off to suit. Large manufacturing concerns can afford to set up their own systems of fits but smaller companies, individual engineers and students need a standard-practice guide even though they may have considerable engineering experience.

There is not space here to give details of the proposal but a very good outline is given in the May 1953 issue of "Standardization", available for 25 cents, while the complete draft of the proposed standard is available for 75 cents, both from the American Standards Association, 70 East 45th St., New York 17, New York.

The chief point we wish to emphasize is that here is the first real opportunity in 28 years for this country to set up a coordinated, comprehensive, proved system and yet it is possible that it might go by default because of lack of active expression of interest by the general run of the people mentioned in our first paragraph. People write to radio and television directors to express their views on much less important matters. Why not write yours at once to the American Standards Association in New York?

American industry should consider this ABC proposal for its own use.

—W.S.B.

bright strong easy to form

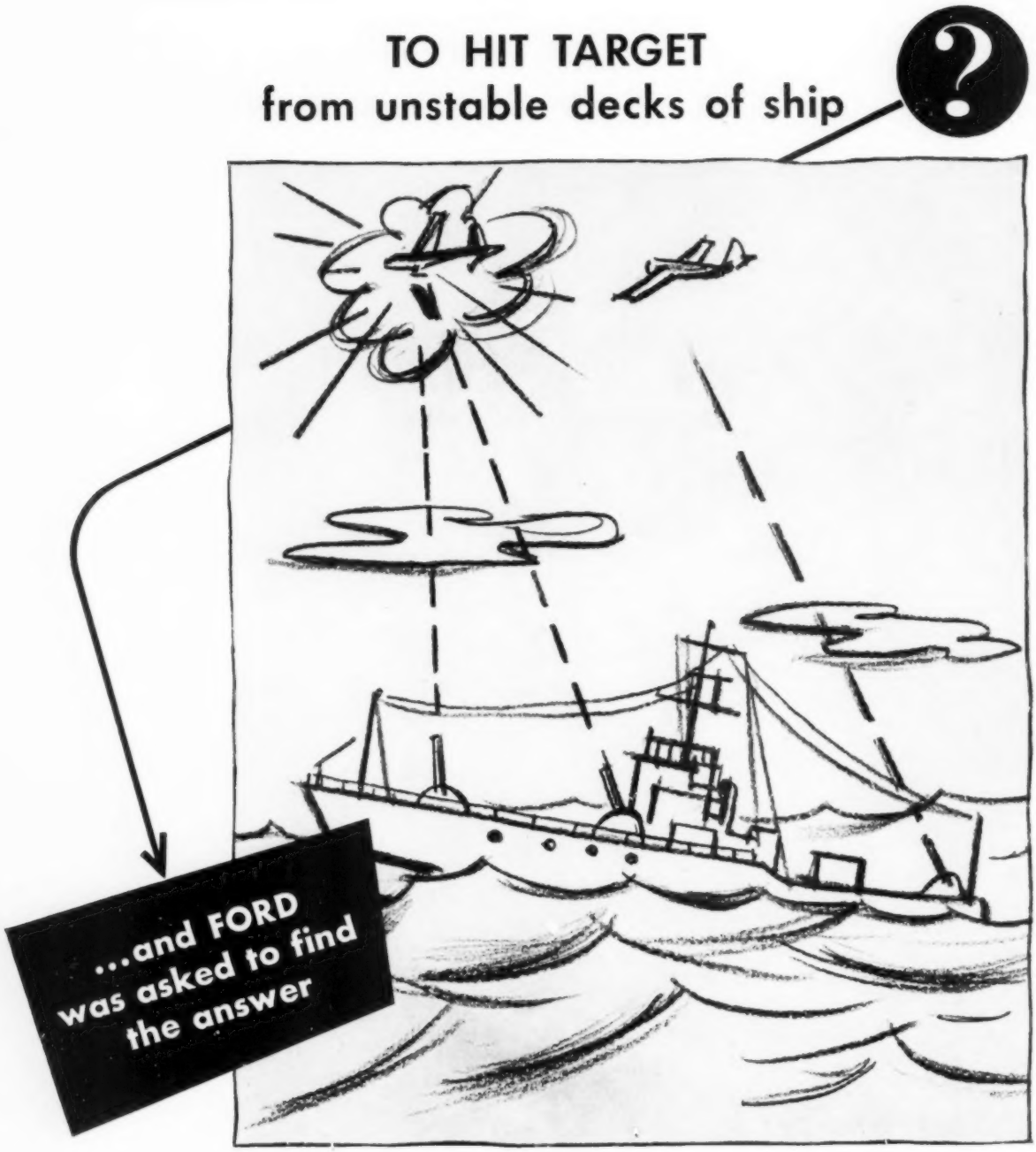
for everything AND the kitchen sink

SINK RIMS are an excellent example of Superior Stainless in service—all the way from initial ease of fabrication, through simplicity of installation, to life-long durability on the job. Rims of Superior Stainless stay bright with a wipe—can't rust, peel or chip—add value to the entire kitchen unit! ● Let's help you find your profit-application for Superior Stainless Strip Steel. Write us about your product, today.

Superior *Type* 430 **Stainless** STRIP STEEL

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

TO HIT TARGET
from unstable decks of ship



A rolling, pitching ship... under attack from speedy, diving aircraft... counts on its anti-aircraft guns for protection... these guns must be able to stay on the target regardless of sea conditions. That's why the Ford Instrument Company was called on to design and build a control system that tracks and holds the target range with deadly accuracy.

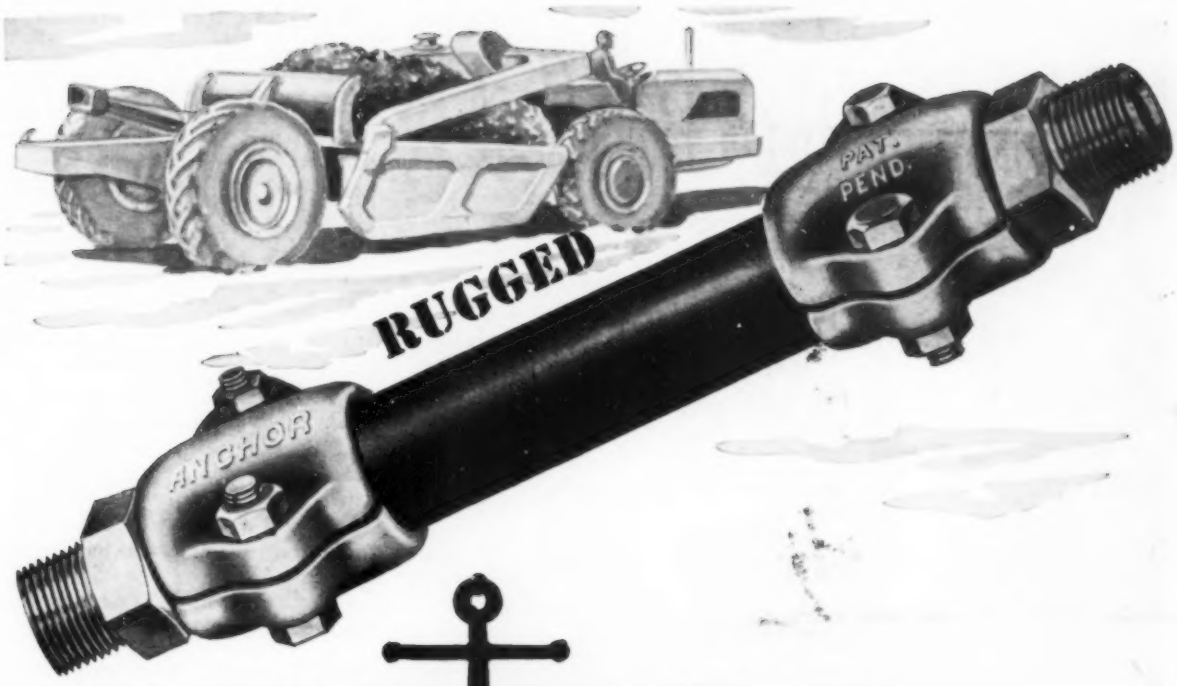
This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

4

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.



ANCHOR

CLAMP-TYPE REUSABLE COUPLINGS

— ideal for heavy-duty original-equipment service or emergency repairs in the field

For high or medium pressures—can be used with one- or two-wire braid hose.

Specially designed clamping segments — impulses can't shake them loose, yet coupling is reusable again and again.

Easy to apply — no special tools needed to assemble couplings and hose. Hose cover need not be stripped to apply coupling.

Neat Installation — made possible by compact design of the Anchor clamp and the use of streamlined Anchor adapter unions and related fittings.

Saves Time — you don't have to wait for repairs because you can make up your hose lengths as needed. Stocking problem minimized.

NEW!
REVOLUTIONARY
ANCHOR FLANCO
SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp halves. Easy to assemble with small automotive-type wrench.

Get more details. Attach coupon to your letterhead and mail today.

ANCHOR COUPLING CO. INC.

Main Office and Factory: LIBERTYVILLE, ILLINOIS

FACTORY BRANCHES: DETROIT, MICHIGAN • DALLAS, TEXAS

Anchor Coupling Co. Inc.
Dept. PE 103 Libertyville, Illinois
Yes, I'm interested in
☐ **Anchor one-wire braid hose assemblies**
☐ **New Anchor Flanco Split-flange clamp-type coupling**
Send me information.

Name.....**Title**.....

Company Name.....

Company Address.....

City.....(.....) **State**.....

D-54

a new
Automotive Water Pump Seal...
WITH SPRING ENCLOSED
SYNTHETIC RUBBER FLEXING MEMBER
METAL BAND
SEAL RETAINER
PRECISION-LAPPED-SEALING WASHER
SPRING
HOLDING DENTS
"JOHN CRANE"
Type 11A* "Pressed-In" Seal
Since the spring is enclosed by the synthetic rubber flexing member, this new "John Crane" Type 11A Seal has definite advantages on small water pump or other liquid seal applications where it is desirable to protect the spring from corrosive liquids. It also eliminates the need for expensive corrosive resistant spring material. Additional outstanding design features of this seal are:
1. Compact—a "pressed-in", one unit seal.
2. Washer held stationary by metal retainer; no damaging stresses on flexible bellows.
3. Easy to install on production lines.
4. Retainer does not contact the shaft, thus many sizes can be handled, namely, 3/8", 1/2", 5/8" and all intermediate shaft diameters.
5. Handles pressures to 50 psi and temperatures to 212° F.
6. For use with high shaft speeds (6000 RPM and up) and where shaft vibration is present.
7. Mass production means low unit cost.
CRANE PACKING COMPANY
1845 Cuyler Ave., Chicago 13, Ill.
Our new illustrated catalog is available.
Typical Installation of Seal in Small Circulating Pump.
*PROTECTED BY U.S. Patent No. 2645508 also patents in all principle foreign countries.
JOHN CRANE
CRANE PACKING COMPANY

MINIATURE RADIO

FORT MONMOUTH—A wrist radio with a 40-mile range is the latest development of the Signal Corps. Dubbed the "Dick Tracy", the two and five-eight ounce radio is worn on the wrist in the same manner as a watch. Contained in a plexiglass case two in. long, the set is one and an eighth inches wide, and three quarters of an inch thick. The tiny size is made possible through replacement of the conventional vacuum tubes with five transistors and other miniature components, one of which is a mercury battery scarcely larger than the tip of a pencil. The wiring in the chassis is made up of printed circuits produced by an etching process.

A short antenna wire and a cord connecting the radio with the hearing aid type of receiver worn on an ear, are concealed up the users sleeve. Range is about 40 miles.

LIGHT METAL BUILDING

FIRST ALUMINUM SKYSCRAPER—the 410 ft Alcoa Building in Pittsburgh's Golden Triangle—was dedicated last month. Started in May 1950, the structure claims more building innovations than any other erected recently. It uses aluminum wherever the metal can be used: exterior walls are sheeted with aluminum panels, aluminum window frames are reversed for indoor cleaning, offices are heated and cooled from aluminum ceilings, all electrical wiring and most of the plumbing is aluminum, and the interior trim, partition framing and light fixtures are all light metal, too.

Now Available

AUTO-LITE Silicone-insulated Wire

Auto-Lite Silicone-insulated Wire is immediately available for use on civilian products — where extreme temperature ranges occur. Check these advantages of Auto-Lite Silicone-insulated Wire for both high- and low-voltage applications.

- ☆ **Withstands extreme temperature ranges — from −60°F to 400°F.**
- ☆ **Good retention of electrical properties.**
- ☆ **Highly resistant to bacteria and fungi.**
- ☆ **Extremely good weather aging qualities — does not become brittle.**

Auto-Lite has the facilities available to accommodate your biggest demands for Silicone-insulated Wire. Inquire today!

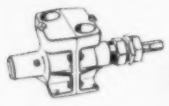
THE ELECTRIC AUTO-LITE CO.
Wire and Cable Division
Port Huron, Mich. Hazleton, Pa.

* * *

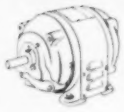
Tune in "SUSPENSE!"... CBS Radio Mondays ... CBS Television Tuesdays

AUTO-LITE
Wire and Cable

If you use pumps in your products... get ECO economy and efficiency



low cost ECO pump



smaller, lower-cost motor

$avings you can't afford to miss!

Eco pumps for use as original equipment in a wide range of machines, devices and appliances, are manufactured by the most modern volume production methods, to offer high quality pumps at low competitive prices.

In addition, the Eco pump's efficiency permits the use of smaller, lower-cost motors permitting overall savings that no cost-conscious design or production engineer can afford to ignore.

Whether you want to pump water or viscous greases—chemicals or carbonated beverages—vinegar or vitamins—molasses or motor oil—if it is a clear fluid, and flows, there is an Eco Pump for the service.

- Positive displacement type with two opposed, axially-oscillating impellers equivalent to duplex piston action.
- Pressures to 150 psi. Capacity to 10 GPM. High suction lift. Self-priming. Non-foaming. No air entrainment. Continuous non-surging flow.
- Operate in any position and submerged, pumping high or low temperature fluids.
- Impellers of synthetic rubber, plastics, Teflon or porous metals for all requirements.
- A unique engineering service matches pumps to specific problems. Get Eco Economy. Ask the leaders in small pump production.

ECO Engineering Company
12 New York Ave., Newark 1, New Jersey

ECO fluid engineering

NEW BOOKS

Animal Glue In Industry

5½ x 8¼ *in.*, 101 *pp. Prepared and published by the National Association of Glue Manufacturers, Inc.*, 55 *West* 42 *St., New York* 18, *N. Y.*, $1.00 *cloth-bound*, $.40 *paper-bound.*

This volume outlines in some detail satisfactory, proven methods for the proper utilization of animal glue with principal areas of application in the adhesive, sizing and coating, composition, and colloidal fields. No attempt has been made to cover all industrial uses; rather, an effort has been made to select for illustrative purposes a few of the more salient applications of the product in each of its major field of uses.

Proceedings of Symposia In Applied Mathematics, Vol. IV

M. H. MARTIN, *Editor*, 7 x 10 *in.*, 186 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 *West* 42 *St., New York* 36, *N. Y.*, $7.

This volume contains the papers which were presented at the Fourth Symposium in Applied Mathematics of the American Mathematical Society held at the University of Maryland on June 22 and 23, 1951. The subject of the Symposium as Fluid Dynamics, and the four sessions were devoted to Turbulence, Compressible Flow, Foundations, and Incompressible Flow. The Symposium was cosponsored by the U. S. Naval Ordnance Lab., White Oak, Maryland.

The papers included are listed below. Mr. Meyer's paper appears in abstract form since it was published in full in "Quart. J. Mech. Appl. Math., Vol. 5 (1952).

1. Some Aspects of the Statistical Theory of Turbulence. By S. Chandrasekhar.
2. A Critical Discussion of Similarity Concepts in Isotropic Turbulence. By C. C. Lin.
3. The Nonexistence of Transonic Potential Flow. By Adolf Busemann.
4. On Waves of Finite Amplitude in Ducts (Abstract). By R. E. Meyer.

CAPABLE COMPONENTS OF ALL FROM A TO Z

Aetna Bearings and Precision Parts are helping equipment do a better job in almost any field you can name. Reason is, designers, engineers, and manufacturers know that nothing contributes more to equipment efficiency and servicability than quality anti-friction components.

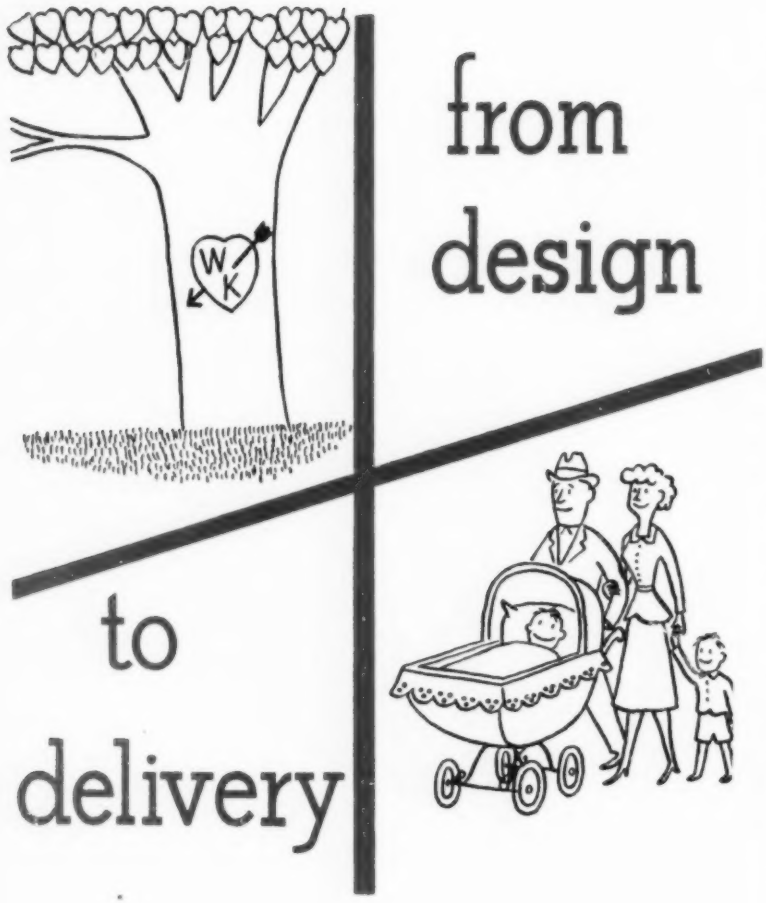
Aetna cooperative engineering has successfully solved over 2000 special anti-friction problems for American manufacturers. Tackling such problems and designing special bearings or precision parts to solve them has been a basic part of Aetna's business for more than a third of a century.

As an executive it may pay you handsomely to find out what Aetna products can do to help make your product more useful, easier to sell, or cheaper to make. A letter, wire or 'phone call will place our engineers at your disposal.

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts.

AETNA BALL AND ROLLER BEARING COMPANY
4600 Schubert Avenue • Chicago 39, Illinois

BRANCH OFFICES COAST-TO-COAST: • Albany • Atlanta • Auburn • Baltimore • Binghamton • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Denver • Detroit • Hartford • Houston • Jacksonville • Los Angeles • Newark • NewYork • Niagara Falls • Philadelphia • Pittsburgh • Providence • Richmond • Rochester • San Francisco • Seattle • Syracuse • Trenton • Utica • Waterbury • Worcester. *See your classified 'phone directory for addresses.*



LOOK TO WATERTOWN

We are prepared to handle any custom molding job . . . regardless of size or shape . . . in practically any plastic material . . . by compression, injection, or transfer. Complete design, engineering, chemical, and production facilities. If you have a problem in plastics, let us help you. Write today!

THE WATERTOWN MFG. CO.
500 ECHO LAKE RD., WATERTOWN, CONN.

5. On the Problem of Separation of Supersonic Flow from Curved Profiles. By T. Y. Thomas.
6. On the Construction of High-speed Flows. By G. F. Carrier and K. T. Yen.
7. An Example of Transonic Flow for the Tricomi Gas. By M. H. Martin and W. R. Thickstun.
8. On Gravity Waves. By A. E. Heins.
9. Hydrodynamics and Thermodynamics. By S. R. De Groot.
10. Nonuniform Propagation of Plane Shock Waves. By J. M. Burgers.
11. Theory of Propellers. By Theodore Theodorsen.
12. Numerical Methods in Conformal Mapping. By G. Birkhoff, D. M. Young, and E. H. Zarantonello.
13. Flow of Viscous Liquid through Pipes and Channels. By J. L. Synge.
14. The Method of Singularities in the Physical and in the Hodograph Plane. By Alexander Weinstein.

Engineering Statistics And Quality Control

IRVING W. BURR, *Professor of Mathematics and Research Associate in Statistical Laboratory, Purdue University, 6½ x 9½ in., 422 pp. Published by McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y., $7.*

A textbook study, written primarily for junior, senior and graduate students of engineering and physical science, presenting a sound, clear, unified and practical approach to a working knowledge of statistics. Since students at this level have usually reached some mathematical maturity, a number of appropriate derivations are included. Though the book has been designed for college usage, it is also valuable to those in industry.

Primary emphasis throughout the book is upon statistics used directly by industry, and methods presented are applicable to engineering research. Treatment is balanced between theory and practice. Enough theoretical material is included to give a sound background and satisfy the pure statistician or mathematician while many random sampling experiments are given, the results of which are shown, to aid the student who cannot easily follow the derivations. Many illus-

Try

WIRELON

on your

imagination

Wirelon, the different kind of rope, has properties not found in any other rope. That's why it does many jobs better than they have ever been done before. Nobody yet knows all the possibilities of Wirelon, but men of vision and imagination in many fields have improved products and processes with it.

A few: Wirelon makes long-lived starter cords for small engines; safely retracts hoses of gasoline pumps, has proved to be the best type of tiller rope, has numerous applications in television and radar, rolls back tops on convertibles, adds striking beauty to many products.

Try Wirelon on your imagination. Write us on your letterhead and we will send you a sample piece of Wirelon, with specifications, so you can explore its possibilities.

Rochester Ropes, Inc.

Route 15, Culpeper, Virginia

COMBINES the strength of steel with the toughness of nylon—a Rochester quality steel wire core completely encased in an extruded covering of nylon.

RESISTS FATIGUE. In service where cable is repeatedly bent, Wirelon has up to 500 per cent longer life than uncoated cable.

WITHSTANDS ABRASION, kinking, fraying and other wear.

OPERATES reliably in extremes of temperature.

SAFE, smooth, easy to handle.

JEWEL-LIKE, strikingly handsome.

SIZES: 3/64 to 1⅛ inch diameter.

COLORS: natural nylon and many gem-like tones.

Rochester Wire Ropes—
Used Wherever
Quality is Important

your best bet is

FLEX-O-TUBE

Supplied in Assemblies

Flex-O-Tube will help you determine the assembly needed or work to your own specifications. In either case, modern facilities and latest inspection techniques assure you a uniformly high quality product delivered promptly.

Supplied for Field Assembly

Flex-O-Tube hose is also supplied in bulk coils with reusable fittings for field assembly. Complete range of sizes and types.

If you use flexible hose in your product or for replacement in your plant, it will pay you to specify Flex-O-Tube. For here is a name that has stood for finest quality and dependable service for more than a quarter of a century.

In the development of new uses for flexible hose, Flex-O-Tube provides you with dependable experience in the field. When used for replacement in industrial maintenance, Flex-O-Tube provides you with a complete range of products that are easy to assemble and long on performance.

Whatever your needs, why not discuss them with the local Flex-O-Tube field engineer. You'll find there are many good reasons why industry has relied on Flex-O-Tube for miles and miles of flexible hose products.

Please send me your free ☐ aircraft catalog. ☐ industrial catalog.

Name .....

Company .....

City ..... Zone ..... State .....

Address .....

FLEX-O-TUBE

DIVISION OF MERIDAN CORP.

762 FOURTEENTH • DETROIT 16, MICHIGAN

trative examples and problems for student solution serve to clarify the applicational methods.

The text presents frequency tabulation as a useful tool and discusses averages and variability with special emphasis on those measures which are of greatest use in engineering statistics. The normal curve with method for fitting and testing goodness of fit is included. After this there is a chapter covering probability followed by a complete discussion of control charts and their applications. Acceptance sampling based both upon attributes and variables is considered.

Engineering Drawing, Basic Problems, Series A

CHARLES J. VIERCK, CHARLES D. COOPER *and* PAUL E. MACHOVINA, *Professors of Engineering Drawing, The Ohio State University,* 8½ x 11 *in.,* 59 *problem sheets. Published by McGraw-Hill Book Co., Inc.,* 330 *West* 42 *St., New York* 36, *N. Y.,* $3.50.

This problem book is intended for use with "Engineering Drawing" by French and Vierck (Eight Edition) in covering the fundamental subjects ordinarily taught in an elementary first year engineering drawing course.

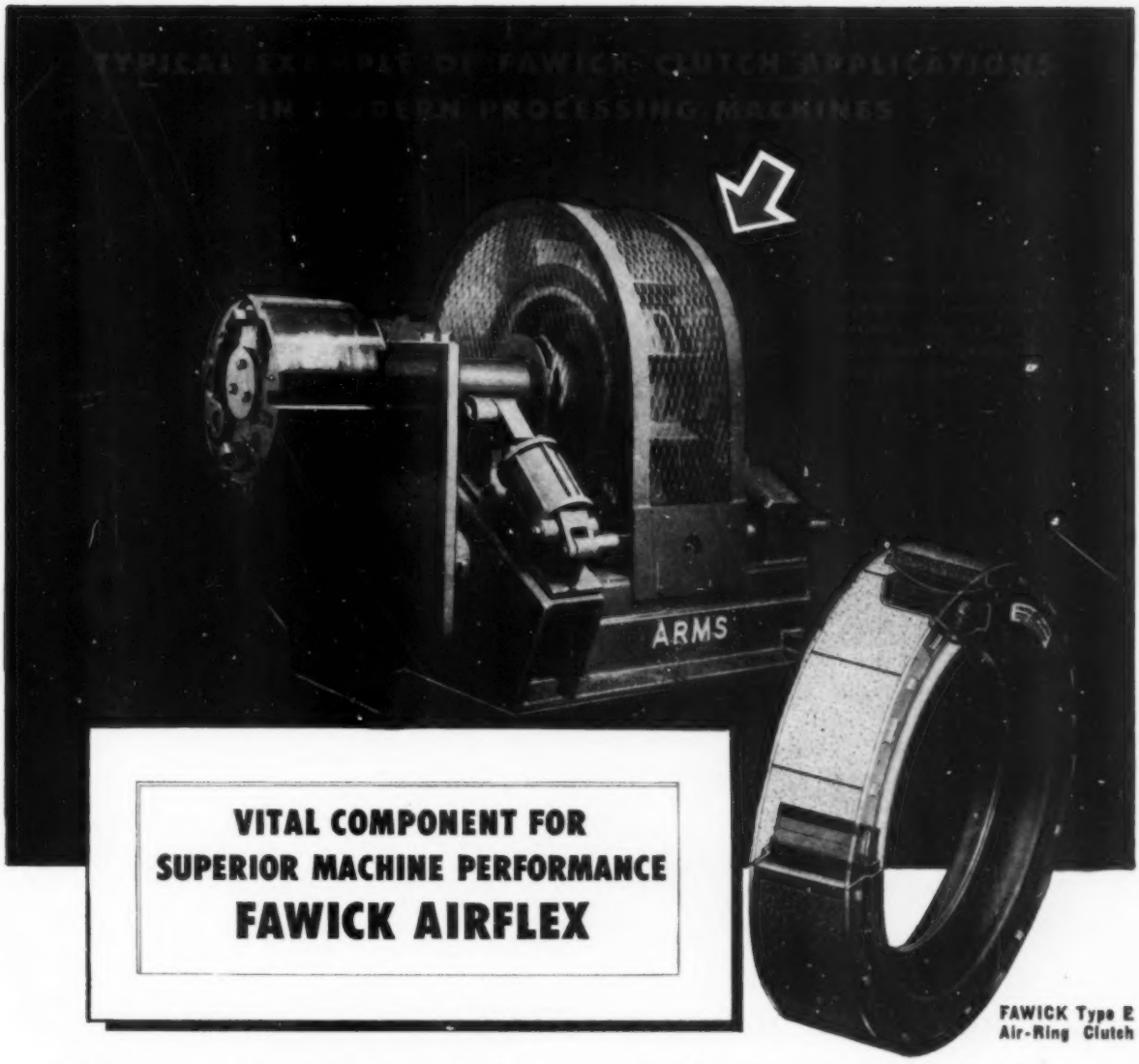
Instructions at the beginning of the book give study paragraphs in the textbook relevant to each of the 59 problem sheets.

Pipe and Tube Bending

PAUL B. SCHUBERT, 6 x 9 *in.,* 193 *pp. Published by the Industrial Press,* 148 *Lafayette St., New York* 13, *N. Y.,* $5.

This work is designed to do a specific job—to help designers, engineers, mechanics, in fact, anyone who is concerned with the bending of pipe, to do a better job. Here, for the first time, have been assembled the technical data and the practical know-how on bending both ferrous and non-ferrous pipe and tube in all sizes.

Covering equipment and methods for pipe bending both in the shop and in the field, it illustrates the outstanding types of bending equipment which are available, describes the operating characteristics of each, and shows how



FAWICK Type E
Air-Ring Clutch

VITAL COMPONENT FOR SUPERIOR MACHINE PERFORMANCE

FAWICK AIRFLEX

There is a sound reason why so many of the finest industrial machines incorporate FAWICK AIRFLEX Clutches and Brakes—*they guarantee top performance*. Fawick units are essential components, vital to both manufacturers and users.

As a *manufacturer* of processing machinery, you can be sure of dependable power transmission with Fawick's simplified design and unmatched endurance. As a *user* of Fawick-equipped machines, you can realize better production and efficiency.

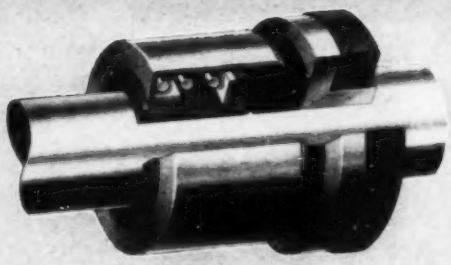
Why not take advantage of the FAWICK ENGINEERING SERVICE to achieve peak clutch and brake performance for your production equipment.

FAWICK AIRFLEX DIVISION
FEDERAL FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO

For further information on Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 400-A.

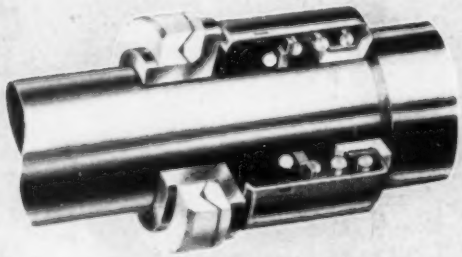
FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

Garlock "Package" Seals
FOR ROTATING PUMP SHAFTS



Type BB-21A—Garlock Package Seal of standard construction with brass shell, brass washer, and Buna-N bellows.

	TYPE BB-21A	TYPE AA-21A
Liquids	For water, oils, alcohol, solvents (except aromatic, chlorinated and ketone types) and other liquids (except strong acids).	For very strong acids, oils, solvents (including aromatic, chlorinated and ketone types) and all other liquids.
Equipment	Rotating shafts of centrifugal pumps, process pumps, chemical pumps, agitators and similar applications.	
Sizes	For shafts from ⅜" to 3" diameters.	
Temperatures	With Buna-N bellows up to 212°; with silicone bellows up to 450° F.	Up to 450° F.
Pressures	Up to 150 p.s.i.	Up to 150 p.s.i.



Type AA-21A—Garlock Package Seal with hat-shaped "Teflon" drive ring, brass or 316 stainless steel shell and washer, "Teflon" 'O' ring, and "Teflon" two-piece vibration ring.

✓ CHECK THESE IMPORTANT FEATURES

- ☐ Occupy very small space
- ☐ Completely assembled—ready to install
- ☐ Proven performance at low cost
- ☐ Both types are dimensionally interchangeable

In both of these Package Seals, a leakless seal is provided by a positive contact between carefully lapped metal-to-carbon mating surfaces. All metal parts in both types are available in plated-brass, Ni-Resist, stainless steel with malcomized face, Garlock "B" iron, and others.

For complete details, ask your Garlock representative or write us about your sealing problems.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
Branch Offices in Most Principal Cities

GARLOCK
PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

each is applied to particular jobs. With this information, it is possible to compare methods and equipment and select those which are most suitable.

In addition, the author gives convenient formulas for determining length and minimum radii of bends, shows the effect the method of bending has on minimum radii, discusses in detail the use of fillers, mandrels, dies, etc.

The list of chapter headings is as follows: Methods of Bending, Lengths and Minimum Radii of Bends, Use of Fillers and Mandrels in Bending, Compression Bending, Draw Bending, Ram and Press Bending, Roll Bending, Wrinkle-Bending, Hot Bending of Large Sized Pipe and Tubing, Production Pipe Bending Using Wooden Forming Dies, Pipe and Tube Coiling, Bending Operations in the Field, Procedure for Dimensional Drawing of Bent Parts, and Classification of Tubing.

Elements of Heat Treatment

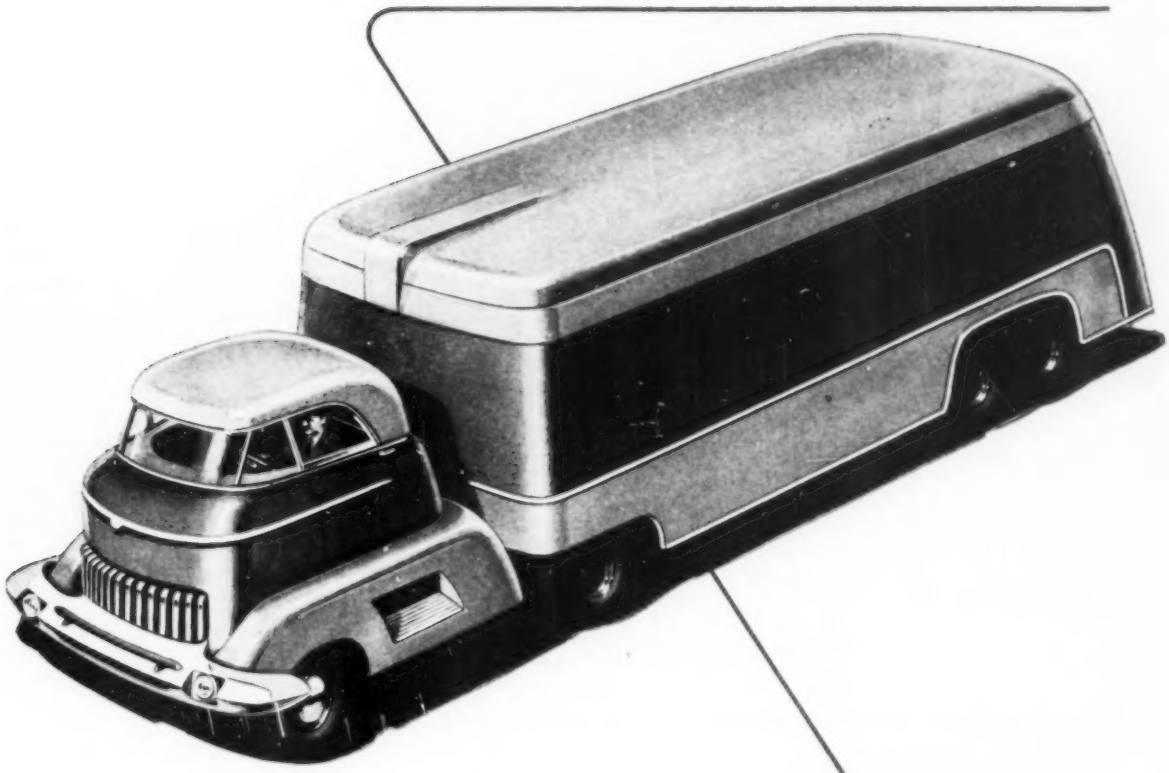
GEORGE M. ENOS *and* WILLIAM F. FONTAINE, *Purdue University*, 6 x 9 *in.*, 286 *pp. Published by John Wiley and Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $5.

Written in simple language, this book provides a thorough grounding in the basic principles governing the application of heat to alter the mechanical properties of metals.

The authors define the major heat treatment processes—annealing, hardening, tempering, and normalizing—and show how each process is used to get the metal characteristics needed for a specific job. Background information on the properties of metals and alloys is presented to develop the reader's appreciation of the changes wrought by heat treatment. Casting, forging, rolling, welding, machining, and other processes related directly or indirectly to heat treatment are briefly discussed. Cartoon-type illustrations lend clarity and interest to the development.

This book will be of interest to readers in the following groups: (1) Personnel in commercial plants who wish to know the principles behind heat treatment without attending a formal course; (2) mechanical engi-

Specify **N·A·X** HIGH-TENSILE STEEL for Lighter Weight, Longer Life and Operating Economy



N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures, and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

Savings in vehicle weight, with no loss in structural strength, increase the payload ratio and give greater operating economy when you make it a point to specify N-A-X HIGH-TENSILE steel for your highway equipment.

KEEP YOUR SCRAP MOVING TO YOUR DEALER

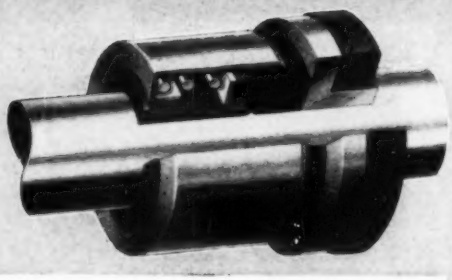
MAKE A TON OF SHEET STEEL GO FARTHER Specify— N·A·X HIGH-TENSILE STEEL ... And "MAKE YOUR PRODUCT LAST LONGER"

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

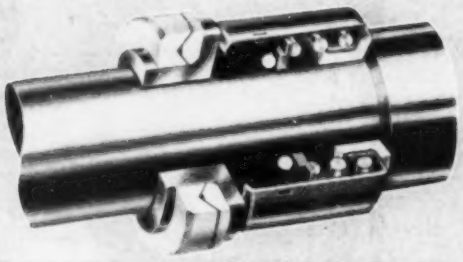
NATIONAL STEEL CORPORATION

Garlock "Package" Seals
FOR ROTATING PUMP SHAFTS



Type BB-21A—Garlock Package Seal of standard construction with brass shell, brass washer, and Buna-N bellows.

	TYPE BB-21A	TYPE AA-21A
Liquids	For water, oils, alcohol, solvents (except aromatic, chlorinated and ketone types) and other liquids (except strong acids).	For very strong acids, oils, solvents (including aromatic, chlorinated and ketone types) and all other liquids.
Equipment	Rotating shafts of centrifugal pumps, process pumps, chemical pumps, agitators and similar applications.	
Sizes	For shafts from ⅜" to 3" diameters.	
Temperatures	With Buna-N bellows up to 212°; with silicone bellows up to 450° F.	Up to 450° F.
Pressures	Up to 150 p.s.i.	Up to 150 p.s.i.



Type AA-21A—Garlock Package Seal with hat-shaped "Teflon" drive ring, brass or 316 stainless steel shell and washer, "Teflon" 'O' ring, and "Teflon" two-piece vibration ring.

✓ CHECK THESE IMPORTANT FEATURES

- ☐ Occupy very small space
- ☐ Completely assembled—ready to install
- ☐ Proven performance at low cost
- ☐ Both types are dimensionally interchangeable

In both of these Package Seals, a leakless seal is provided by a positive contact between carefully lapped metal-to-carbon mating surfaces. All metal parts in both types are available in plated-brass, Ni-Resist, stainless steel with malcomized face, Garlock "B" iron, and others.

For complete details, ask your Garlock representative or write us about your sealing problems.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
Branch Offices in Most Principal Cities

GARLOCK
PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

each is applied to particular jobs. With this information, it is possible to compare methods and equipment and select those which are most suitable.

In addition, the author gives convenient formulas for determining length and minimum radii of bends, shows the effect the method of bending has on minimum radii, discusses in detail the use of fillers, mandrels, dies, etc.

The list of chapter headings is as follows: Methods of Bending, Lengths and Minimum Radii of Bends, Use of Fillers and Mandrels in Bending, Compression Bending, Draw Bending, Ram and Press Bending, Roll Bending, Wrinkle-Bending, Hot Bending of Large Sized Pipe and Tubing, Production Pipe Bending Using Wooden Forming Dies, Pipe and Tube Coiling, Bending Operations in the Field, Procedure for Dimensional Drawing of Bent Parts, and Classification of Tubing.

Elements of Heat Treatment

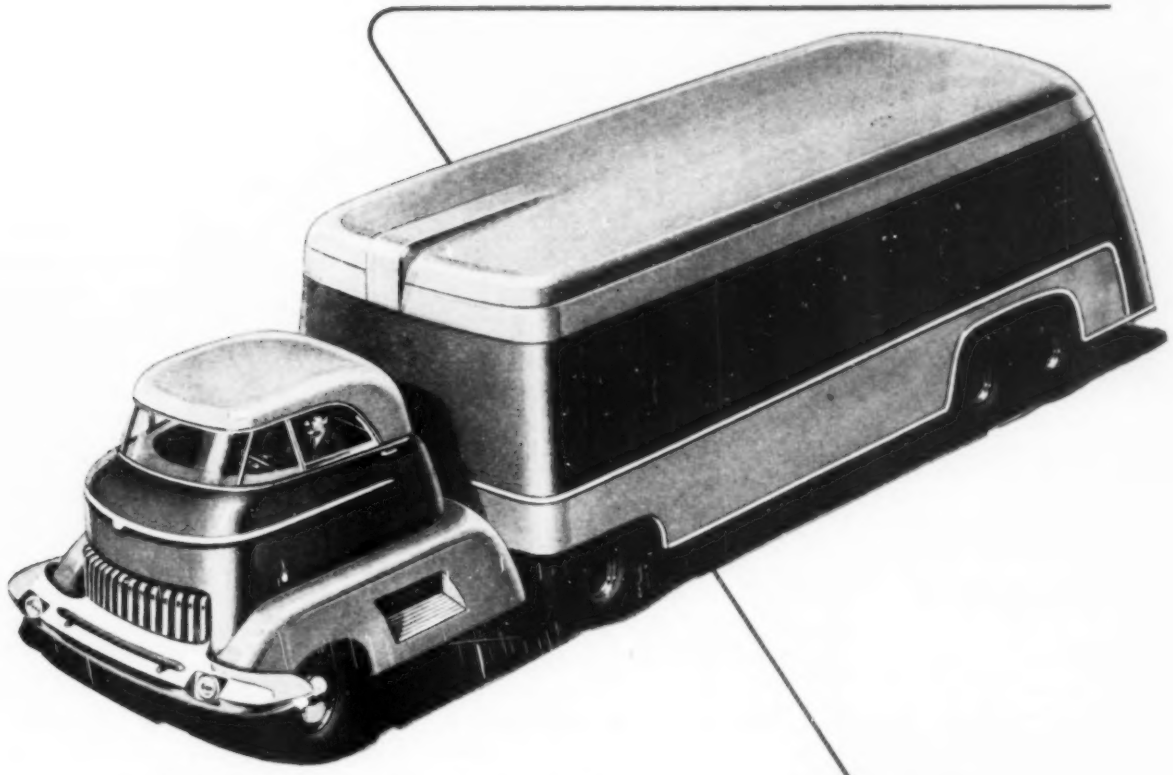
GEORGE M. ENOS *and* WILLIAM F. FONTAINE, *Purdue University*, 6 x 9 *in.*, 286 *pp. Published by John Wiley and Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $5.

Written in simple language, this book provides a thorough grounding in the basic principles governing the application of heat to alter the mechanical properties of metals.

The authors define the major heat treatment processes—annealing, hardening, tempering, and normalizing—and show how each process is used to get the metal characteristics needed for a specific job. Background information on the properties of metals and alloys is presented to develop the reader's appreciation of the changes wrought by heat treatment. Casting, forging, rolling, welding, machining, and other processes related directly or indirectly to heat treatment are briefly discussed. Cartoon-type illustrations lend clarity and interest to the development.

This book will be of interest to readers in the following groups: (1) Personnel in commercial plants who wish to know the principles behind heat treatment without attending a formal course; (2) mechanical engi-

Specify **N-A-X** HIGH-TENSILE STEEL for Lighter Weight, Longer Life and Operating Economy



N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures, and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

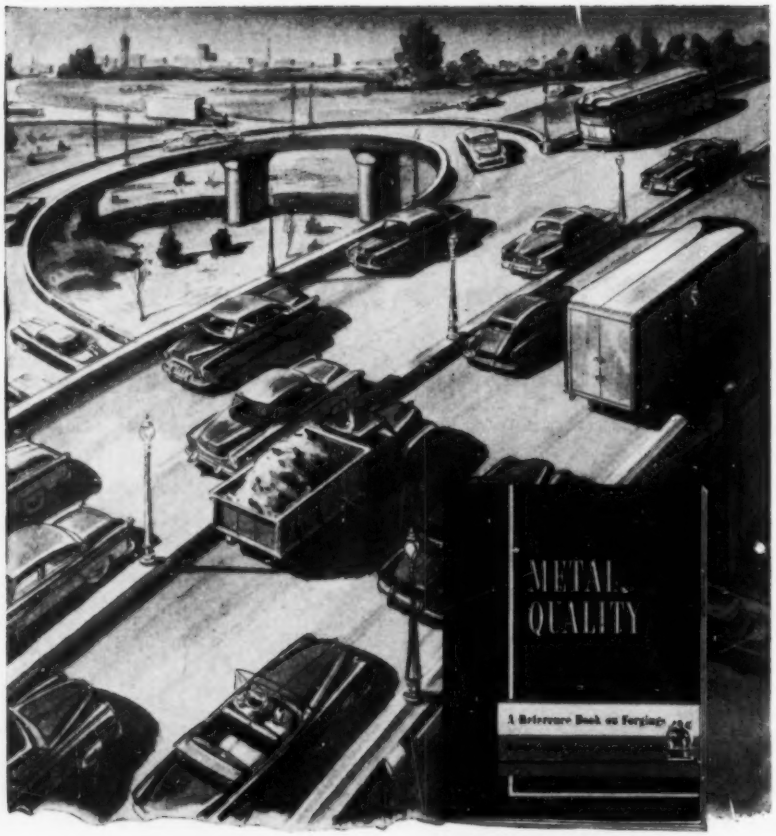
N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

Savings in vehicle weight, with no loss in structural strength, increase the payload ratio and give greater operating economy when you make it a point to specify N-A-X HIGH-TENSILE steel for your highway equipment.

KEEP YOUR SCRAP MOVING TO YOUR DEALER

MAKE A TON OF SHEET STEEL GO FARTHER
Specify N-A-X HIGH-TENSILE STEEL
... And "MAKE YOUR PRODUCT LAST LONGER"

GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division — Ecorse, Detroit 29, Michigan
NATIONAL STEEL CORPORATION



Engineering, production and economic advantages obtainable with closed die forgings are presented in this Reference Book on Forgings. Write for a copy.

This Book Reveals the Matchless Capacity of Forgings!

That makes possible Modern Transportation

What a forging *has*—can't be duplicated! No other method of fabricating parts utilizes fully the fiber-like flow line structure of wrought metals. Now is an excellent time to check your product for cost reductions—to explore possibilities for improving performance—to reduce dead weight. Check problem parts with the unrivaled advantages of closed die forgings and the closed die forging process for producing parts. Double-check all parts, particularly those which are subjected to great stress and strain. Then consult a Forging Engineer about the correct combination of mechanical properties which closed die forgings can provide for your product.

DROP FORGING ASSOCIATION

605 HANNA BLDG. • CLEVELAND 15, OHIO

Please send 64-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1953 Edition.

Name .....

Position .....

Company .....

Address .....

neers who wish a simple review of their college metallurgy or "materials" courses, to solve effectively the heat treatment problems that come up in everyday work; and (3) design engineers, who have little or no interest in equipment, but who wish to know more about the why's of heat treatment, in order to choose metals for particular speculations without relying on handbook selections.

Mathematical Methods for Scientists and Engineers

LLOYD P. SMITH, *Director of Department of Engineering Physics, Cornell University,* 6 x 9 *in.,* 453 *pp. Published by Prentice-Hall, Inc.,* 70 *Fifth Ave., New York* 11, *N. Y.,* $13.35.

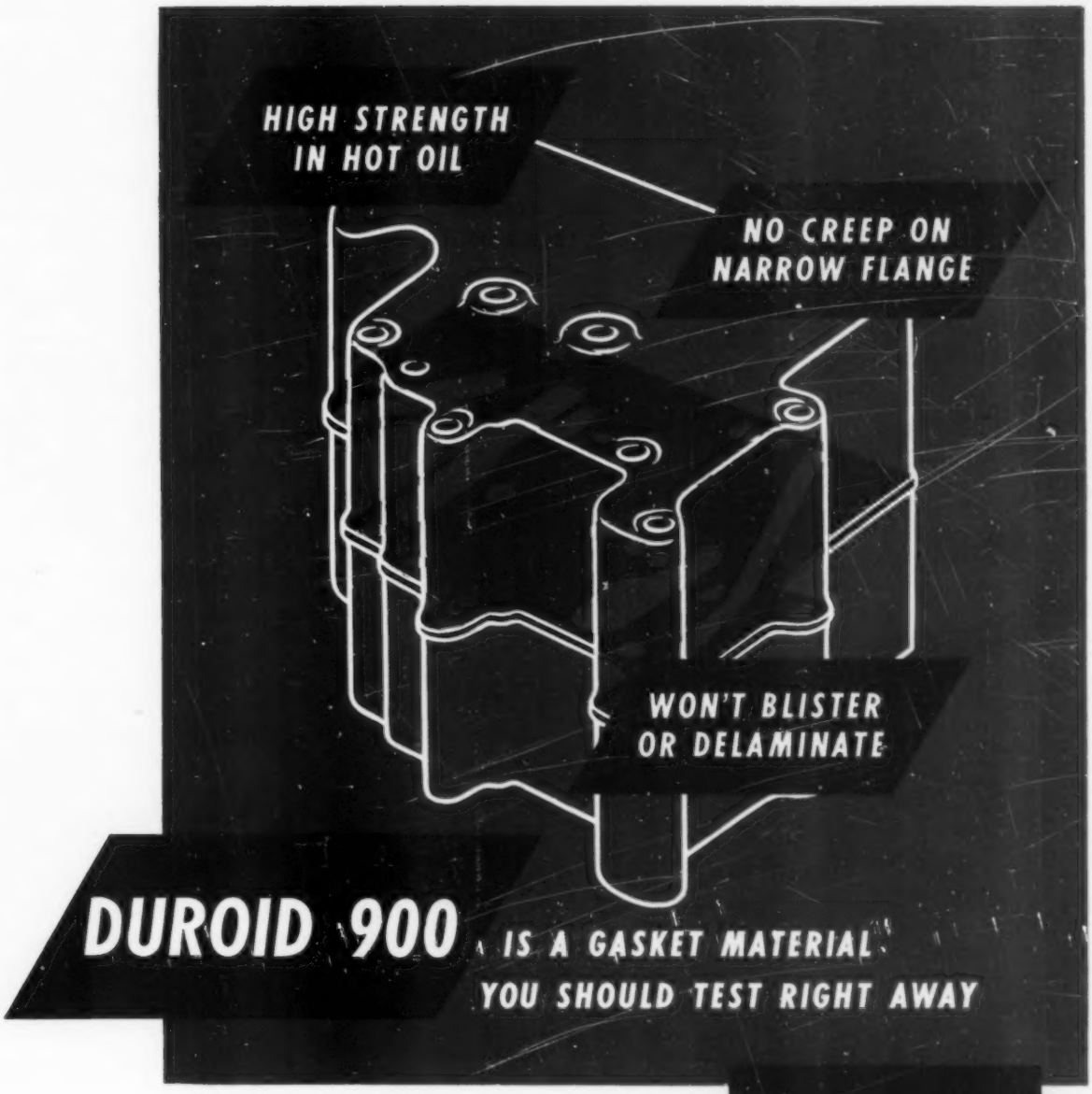
Offering a wide range of mathematical methods used in solving technical problems of scientists and engineers, this book illustrates the conditions under which these methods are used.

The precise statement and functional grouping of all methods covered makes the book understandable to anyone who may lack the analytical and technical background of a mathematician. And although the author furnishes more than an adequate amount of mathematical material, he excludes any treatment of Differential Equations because of the great amount of material to be presented. Rather he shows how advanced methods are actually used in science and engineering.

Each of the many mathematical methods presented is illustrated by completely worked-out examples, the majority of which have been taken from scientific or engineering literature. Carefully developed sets of graded, unsolved problems—also based on actual research experience—follow each chapter. These exercise problems are so presented that the accumulated knowledge of methods explained up to that point is practically applied.

Also treated in detail are complex variables and their applications, asymptomatic expansion, and the representation of functions in terms of orthonormal functions possessing a continuous spectrum.

Chapter heads are as follows: (1) Elements of Function Theory; (2)



DUROID 900 IS A GASKET MATERIAL YOU SHOULD TEST RIGHT AWAY

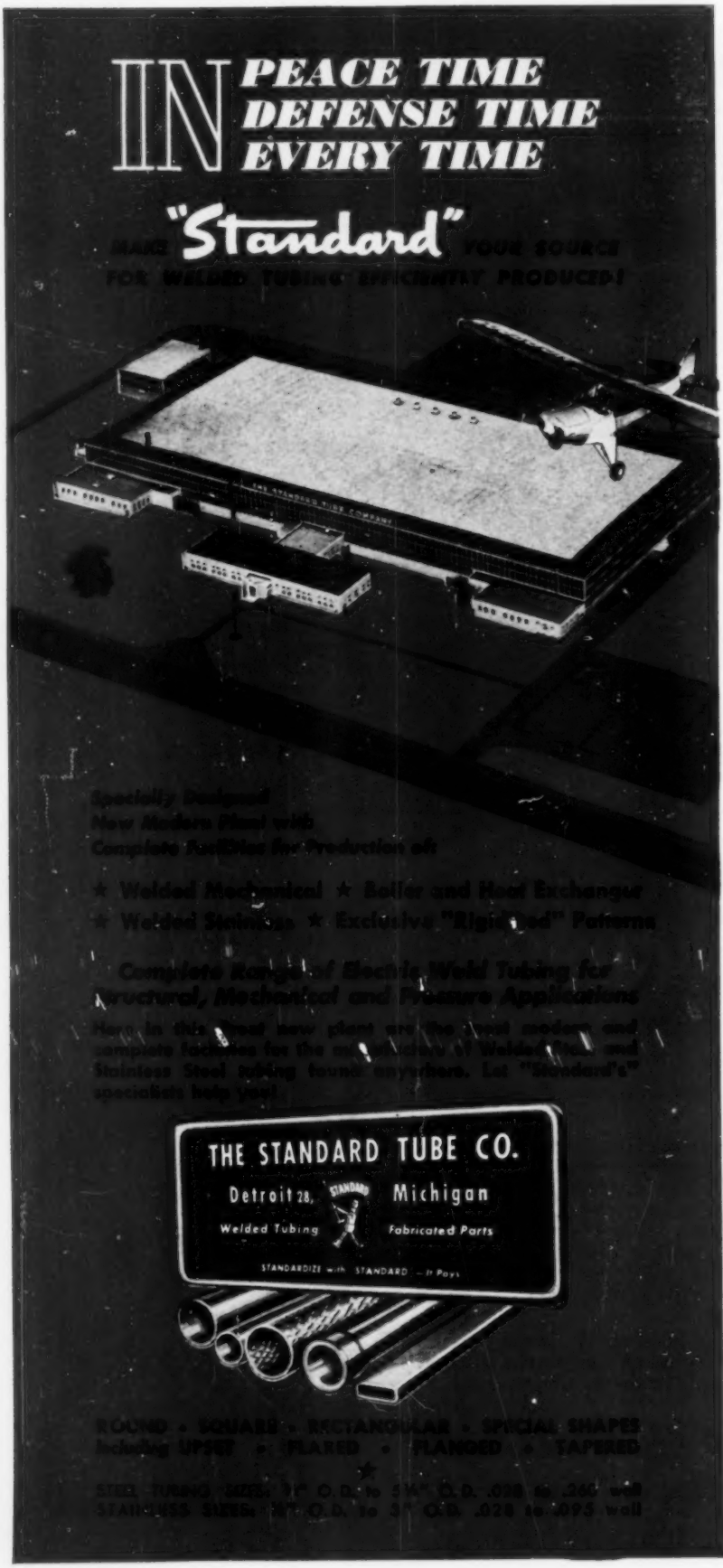
If you put machined surfaces together, you will want to check the improved sealing possible with DUROID 900. Here's a material that gives you compressibility throughout its structure . . . excellent recovery with little torque loss . . . high tensile strength in hot oil. And DUROID 900 won't weaken or harden under pressure in hot oil. It won't blister, delaminate or develop pinholes. In fact, DUROID 900 won't do any of the things you don't want a gasket to do.

Check these facts yourself. We invite rigorous testing. Write now for test data and samples to Dept. E, Rogers Corporation, Goodyear, Connecticut.

Better Parts for Better Products

ROGERS
CORPORATION
Established in 1832

DUROIDS for Gaskets, Filters, Electronics . . . | ELECTRICAL INSULATION for Motors, Transformers, Generators . . . | PLASTICS Molding Compounds and Laminates | SHOE MATERIALS for Counters, Midsoles, Liners



Differential Calculus; (3) Integral Calculus; (4) Space Geometry; (5) Line, Surface, and Multiple Integrals; (6) Theory of Functions of a Complex Variable; (7) Residues and Complex Integration; (8) Representation of Functions by Infinite Series of Functions; (9) Application of Functions of a Complex Variable to Potential and Flow Problems; (10) Algebra of Linear Equations, Transformations and Quadratic Forms; (11) Vector and Tensor Analysis; (12) Orthonormal Function Systems; (13) Orthonormal Functions with a Continuous Spectrum; (14) Integral Equations; (15) Variational Methods; and (16) Probability.

Analytic and Projective Geometry

DIRK J. STRUIK, *Professor of Mathematics, Massachusetts Institute of Technology, 5½ x 8¼ in., 219 pp. Published by Addison-Wesley Publishing by Addison-Wesley Publishing Co., Inc., Cambridge 42, Mass.,* $6.50.

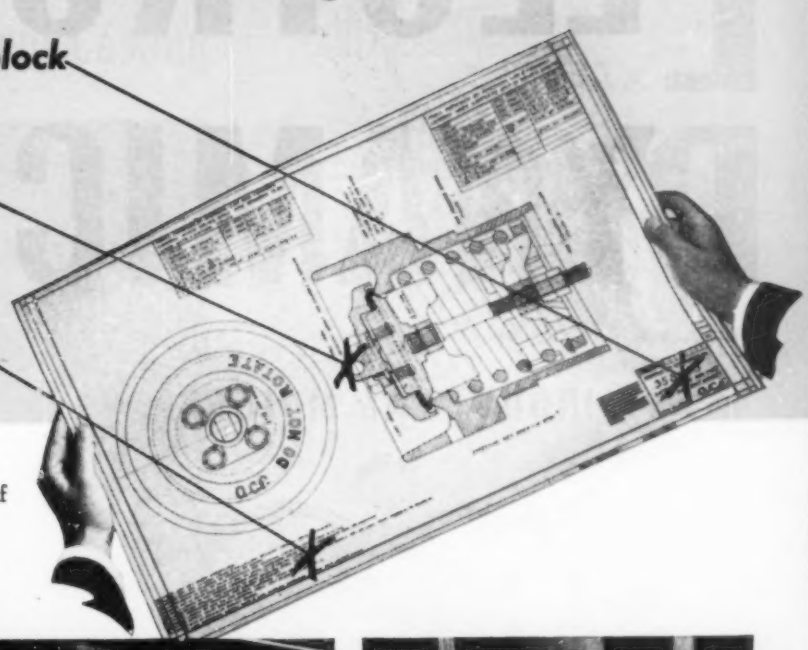
The extension of the mathematical curriculum in colleges has often been at the expense of some valuable fields of more "old-fashioned' mathematics. Among the victims are elementary, projective and algebraic geometry. Neglecting these tends to stifle the understanding of important notions of modern mathematics, physics and engineering. Thus, the author is striving to help find the legitimate place for this field within present curriculums and to stress those fundamentals which are most vital for the understanding of science as a whole.

His book represents an approach to this task by means of a one-term course at the junior or senior level. It presupposes that the reader has done work of the now traditional analytical geometry and calculus type so that he has some understanding of Cartesian coordinates in the plane and in space as applied to straight lines, conics, and some other curves, has had some vector algebra and enough space geometry to recognize a quadric surface. Thus, this discussion starts with affine and projective concepts concerning points on a line and lines through a point. Then, the geometry of plane and space, leading up to conics and quadrics, is developed inside the triple

All these changes made

without one line of retracing

- *substitute new title block here*
- *transfer design to cloth*
- *delete shop notes and lot numbers*



The American Car and Foundry Company, at its Milton, Pa., plant, has to modify hundreds of drawings like the one shown here to meet Army Transportation Corps requirements. Retracing would be much too slow . . . much too expensive. But how else can the job be done? *Kodagraph Autopositive Materials are the welcome answer!*

First—a positive photographic intermediate is made without a negative step by reproducing the original paper drawing on Kodagraph Autopositive Paper. *A fast room-light operation consisting of exposure in a standard print-making machine . . . and processing in standard photographic solutions.* The A.C.F. title block and shop notes are "scissored out" of this print . . . only the essential design remains.

Next . . . the Autopositive cutout of the design area is positioned under a Kodagraph Autopositive Film print, which is a re-usable master containing only the Army Transportation Corps title block. Then this composite is reproduced on a sheet of Kodagraph Autopositive Cloth—the same simple operation as was used previously for processing Kodagraph Autopositive Paper and Film.

Result: a sparkling, extra-durable reproduction comparable to an ink-on-cloth tracing. And the job done—not on the drafting board—but almost entirely in the print-making machine.

Additional time and dollars are saved by using Kodagraph Autopositive Materials to produce print-making masters from specification sheets and blueprints, and protect against the loss of valuable originals.

Kodagraph Reproduction Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

MAIL COUPON FOR FREE BOOKLET

Write today for a free copy of "Modern Drawing and Document Reproduction." It gives complete details on the revolutionary line of Kodagraph Materials, which you, or your local blueprinter, can process conveniently, economically.

EASTMAN KODAK COMPANY,
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a copy of your illustrated booklet giving the facts on Kodagraph Materials.

Name_____ Position_____

Company_____

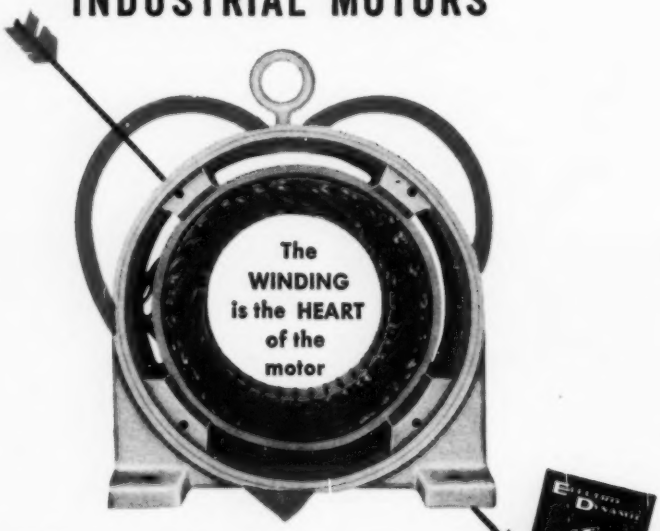
Street_____

City_____ Zone_____ State_____

Kodak
TRADE-MARK

ELECTRO *xtra* DYNAMIC *ependable*

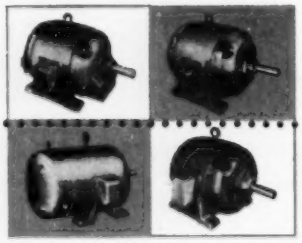
INDUSTRIAL MOTORS



Every Electro Dynamic motor is built with
EXTRA INSULATION in stator slots and between phases
EXTRA IMPREGNATIONS and bakings of the wound stator
EXTRA HIGH-FREQUENCY TESTING of insulation between turns

WRITE TODAY FOR CATALOGUE NO. 1060

From 1 to 250 Horsepower (N. E. M. A. STANDARDS)



One-piece cast iron frames.

Extra large "free-flo" air channels.

Permanently aligned cast iron brackets.

Liberal size grease lubricated bearings.

Also a complete line of Direct Current motors and generators

ELECTRO DYNAMIC
DIVISION OF GENERAL DYNAMICS CORPORATION
BAYONNE, NEW JERSEY

frame of matrical, affine and projective transformations. The algebraic treatment is occasionally exchanged for the synthetic one. At many places, the connection of the goemetrical material of the text with other fields is indicated, notably with axiomatics, descriptive geometry and vector analyses.

Technical Illustration

Compiled by BERTRAM CHOLET, *Higgins Ink Co., Inc.,* 271 *Ninth St., Brooklyn* 15, *N. Y.,* 8 x 10 *in.,* 90 *pp.* $2.50.

The importance of modern industrial visual aids in the form of isometric drawings is discussed as a means of simplifying the reading of blueprints. The advantages of this type of presentation are shown in illustrations of: preliminary design; structure; installation jobs; and a subassembly. A chapter titled, Three Dimensional Drawing, discusses the subject in complete detail giving the basic principles and terminology. The three types of perspective are listed; parallel, or one point; angular, or two point; and three point. The most used in actual practice is angular, or two point, while the least used is three point. All three are described and many illustrations are given to simplify the discussion.

Following this are the principles of axonometric drawing, a form of orthographic projection where the three principal faces of an object are inclined to the picture plane in such a manner that the faces are represented in one view. The major difference between perspective and axonometric drawings is that receding lines of the latter type do not converge. Isometric, Dimetric and Trimetric projection are discussed. The remainder of the book is devoted to mechanical aids to three dimensional drawing.

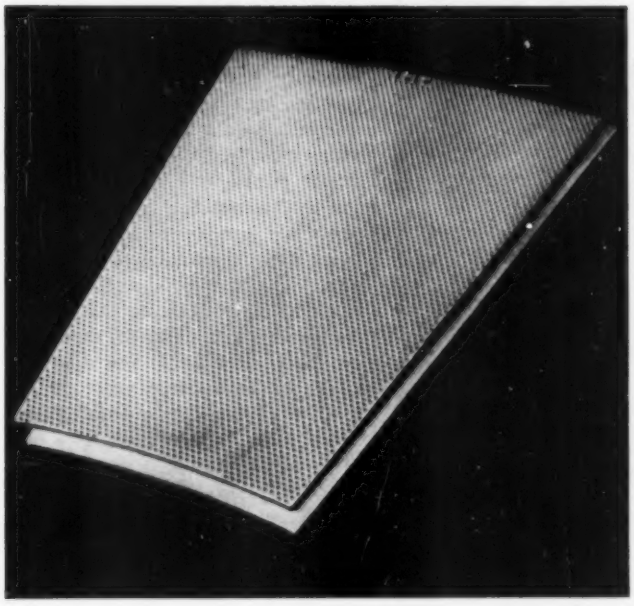
Scintillation Counters

J. B. BIRKS, *Prof. of Physics, Rhodes University, South Africa,* 6 x 9 *in.,* 148 *pp. Published by McGraw-Hill Book Co., Inc.,* 330 *West* 42 *St., New York* 36, *N. Y.,* $4.50.

Practical as well as theoretical in approach, this first book of its kind is a complete review of the most impor-

Now They Are Mass Produced

by HAYNES Investment Casting
Trade-Mark



IMPROVED DESIGN AND MATERIAL—The tiny needle-sharp points covering this plate must resist severe abrasion. Machined points used to wear out frequently because they were pyramidal in shape and highly susceptible to erosion. HAYNES investment casting made it possible to cast the points in a more stable conical shape from a hard, wear-resistant alloy. Life has been increased by 5 to 12 times.

EXCELLENT SURFACE QUALITY—For sanitary reasons, not even the smallest crevice can be tolerated on this cream separator part. Because of the high quality of HAYNES investment castings, it was found that the intricate part could be manufactured on a production basis with a minimum of imperfections showing up during the final polishing operations. This eliminated a great deal of wasted time, work, and metal.

NO MORE MACHINING—HAYNES investment casting eliminated the job of machining these rollers. Service conditions require that the rollers be made of a special alloy which is difficult to machine. They must resist rusting and the cutting action of wire passing over them under tension. The rollers give excellent service life and there are no more machining problems.

HAYNES investment castings can solve some of your own production and design problems. For more information, contact the nearest Haynes Stellite Company office listed below.

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

HAYNES INVESTMENT CASTINGS
Trade-Mark

Sound, dense, high-strength parts available in cobalt-base alloys, nickel-base alloys, iron-base alloys, stainless steels, and alloy and carbon steels.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

MUELLER BRASS CO.

forgings

BRASS · BRONZE
AND ALUMINUM

FORGED TO
PERFECTION

PRECISION
MACHINED
TO YOUR
SPECIFICATIONS

IT'S YOURS! NEW 32-PAGE
FORGINGS ENGINEERING
MANUAL. WRITE TODAY

MUELLER BRASS CO.
PORT HURON · MICHIGAN

112

tant and versatile instrument in modern nuclear research, and will be of value to graduate students and research workers in nuclear physics, physical chemistry, organic and chemistry, and medicine as well as of importance for many industrial, agricultural, biological and other applications of radio-isotopes.

All the factors influencing the performance and use of scintillation counters are discussed in detail. The text includes the first account of the author's complete theory of organic crystal, plastic and liquid phosphors, and the properties of inorganic phosphors are also considered in detail. Every major application of the instrument is discussed, including heavy particle, neutron, beta-ray and gamma-ray spectrometry, studies of short-lived nuclear isomers, and meson studies.

The bibliography of over 200 references is exhaustive and up to date. A great deal of work available only in periodicals has been included, and in many cases simplified treatments have been evolved, without loss of precision.

All the post-1945 studies of scintillation counters, photo-multipliers, and phosphors, together with all major applications up to March 1953, are included. In addition, much new experimental and theoretical work on photofluorescence and scintillation counters not yet published has been included.

Radiation Designer's Handbook

Edited by F. LANGFORD-SMITH, 5½ x 8¾ *in.*, 1,522 *pp. Reproduced and distributed by RCA Victor Div., Radio Corp. of America, Harrison, N. J.*, $7.

This book has been written as a comprehensive, self-explanatory reference handbook for the benefit of all who have an interest in the design and application of radio receivers or audio amplifiers. Everything outside this field—television, radio transmission, radar, industrial electronics, test equipment, and so on—has been excluded to limit the book to a reasonable size.

An effort has been made to produce a handbook which, in its own sphere, is as self-contained as possible. Extensive references to other sources of information have been included for the

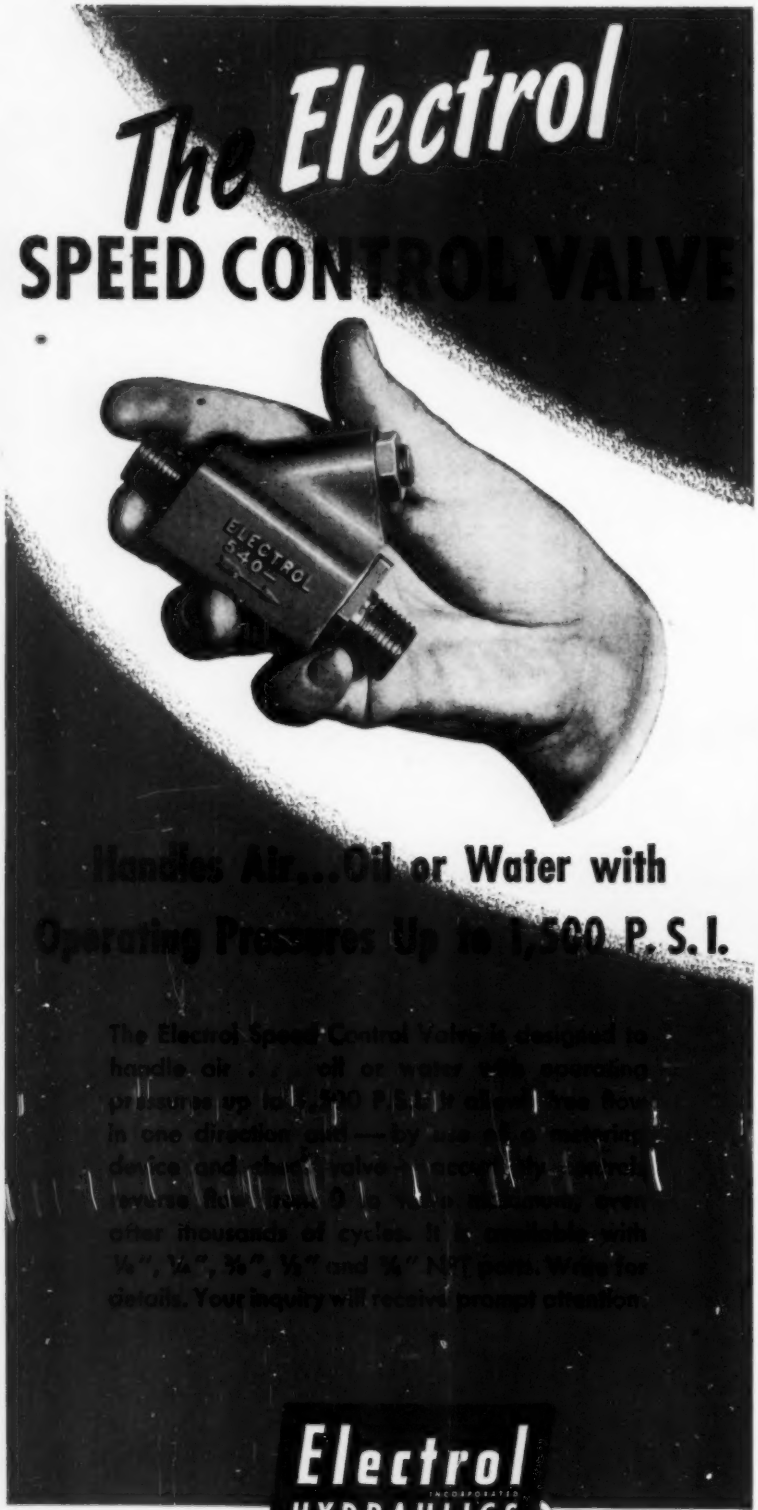
You're always right with AUTO-LITE Plastics

• Plastics and plastic-metal combinations are opening new fields in design as illustrated by these few of many assemblies made by Auto-Lite. Here under one roof at Auto-Lite's great Bay Manufacturing Division in Bay City are the technical skills and production capacity for a new art rendered in plastics. The artistic skill of Auto-Lite's Art and Style Division is available on matters of design and development. Address inquiries to:

THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
723 New Center Bldg., Detroit 2, Mich. • Bay City, Mich.

Tune in "Suspense!" . . . CBS Radio Mondays . . . CBS Television Tuesdays

PLASTICS • WIRE & CABLE • DIE CASTINGS • INDUSTRIAL THERMOMETERS



reader who might require additional detail.

Although the various chapters have been written by individual authors, all are truly the result of team work, each having been carefully and critically examined by several other engineers specializing in that particular field. In this way the accuracy of mathematical calculations and of individual statements was checked and re-checked to ensure that the reader would not be misinformed.

The material is divided into seven parts as follows:

1. The Radio Valve
2. General Theory and Components
3. Audio Frequencies
4. Radio Frequencies
5. Rectification, Regulation, Filtering and Hum
6. Complete Receivers
7. Sundry Data

Engineering Drawing Problems, Series III

CHARLES J. VIERCK, CHARLES D. COOPER *and* PAUL E. MACHOVINA, *Professors of Engineering Drawing, The Ohio State University*, 11 x 18 *in.*, 107 *problem sheets. Published by McGraw-Hill Book Co., Inc.*, 330 *West* 42 *St., New York* 36, *N. Y.*, $4.50.

This problem book, also intended for use with "Engineering drawings" by French and Vierck (Eight Edition) is more comprehensive than the Series A volume which is also announced in this issue. It is intended to cover all the problems on dimensioning which have been chosen so as to teach one particular fundamental at a time, thus freeing the student from considering many points at once. The early sheets cover technique, selection by shape breakdown, and placement. The later sheets emphasize the "function" and "process" principles and the dimensioning of part produced by different manufacturing methods.

The working-drawing problem is presented as a design drawing from which the student, working as a detailer, makes a set of drawings. Thus, in correlating the dimensions of mating parts, etc., practical drafting-room methods and procedures are illustrated and a good understanding of the language of drafting is developed.

marion

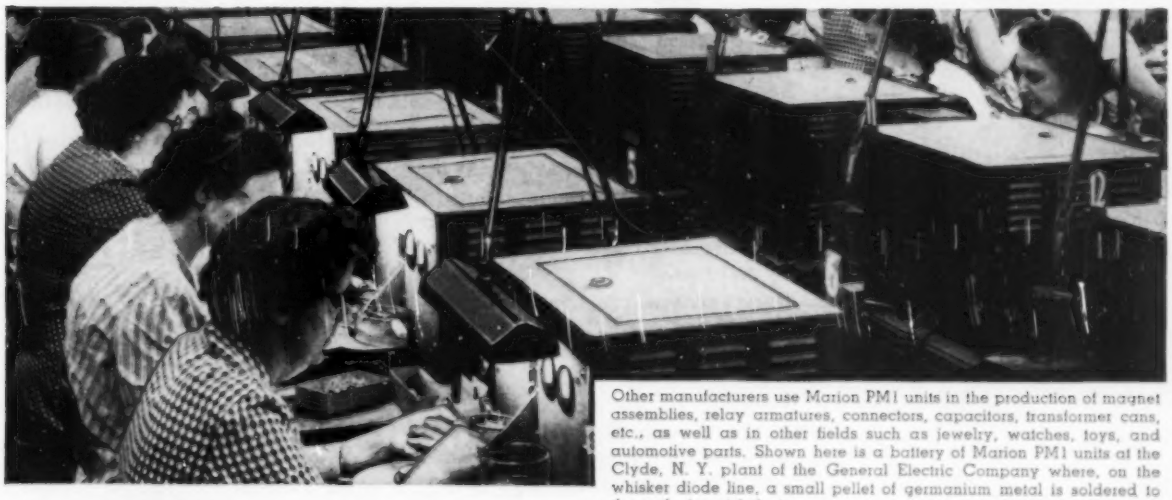
advancement in instrument design

MARION MODEL PM1 INDUCTION SOLDERING UNIT

Low cost, low powered and portable. . . . Size 15¾" x 21½" x 15". 150 lbs. Power supply: 115 volts 60 cycles. Draws 775 watts full load, 100 watts standby.

IMPROVED SOLDERING OF SMALL PARTS AND ASSEMBLIES

Typical of the Marion developments that have helped make Marion stand for "advancement in instrument design" is the Marion Model PM1 Induction Soldering Unit. Originally designed and presently used by Marion for true glass-to-metal hermetic sealing of Marion meters, it also has proven to be a valuable production tool for many purposes. Illustrated above, for example, is Marion's use of the PM1 in the soldering of magnet assemblies where quality and uniformity result.



Other manufacturers use Marion PM1 units in the production of magnet assemblies, relay armatures, connectors, capacitors, transformer cans, etc., as well as in other fields such as jewelry, watches, toys, and automotive parts. Shown here is a battery of Marion PM1 units at the Clyde, N. Y. plant of the General Electric Company where, on the whisker diode line, a small pellet of germanium metal is soldered to the end of a nickel pin.

The Marion Model PM1 speeds up production, reduces costs and improves quality. Heat is generated within the work itself — even in parts otherwise inaccessible. Oxidation, scaling and damage to surface finish are minimized. Soldering of an entire seam or several jig-located parts at one time is readily accomplished.

This is an example of how Marion's belief in "Advancement in Instrument Design" has produced a production tool which not only improves Marion instruments but also provides other manufacturers with better soldering equipment. Marion Electrical Instrument Company, 415 Canal Street, Manchester, N. H.

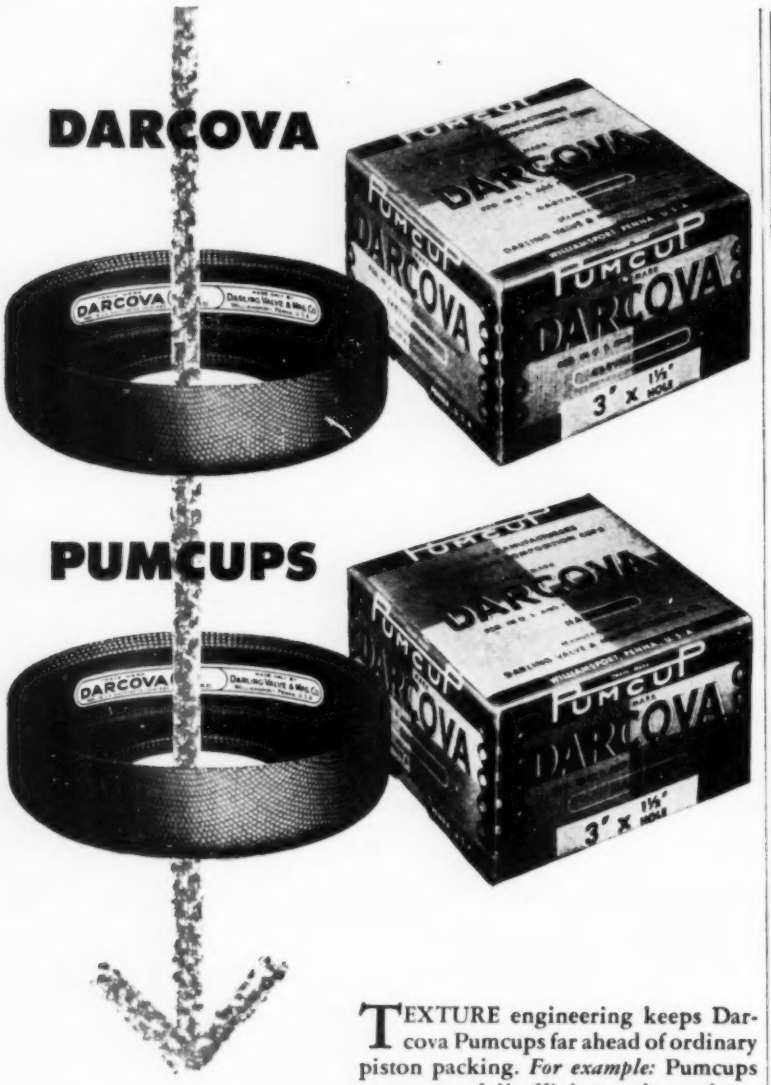
marion meters

Reg. U. S. Pat. Off.

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

Copyright 1953 Marion Elec. Instr. Co.

DARCOVA PUMCUPS



...famous for

- PUMPING EFFICIENCY
- LOWER COST
- LONGER SERVICE

TEXTURE engineering keeps Darcova Pumcups far ahead of ordinary piston packing. *For example:* Pumcups operate at full efficiency throughout their entire life. Fluid slippage is virtually eliminated.

Moreover, you can count on much longer service . . . users report Darcova Pumcups outlast other packing at least 3 to 1!

Write for all the facts on Darcova efficiency: Bulletin No. 4502 on Pumcups for air and hydraulic mechanisms; No. 4401 on Pumcups for reciprocating pumps.

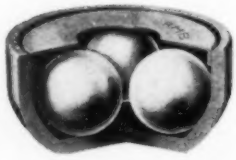
DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

DARCOVA — THE ORIGINAL COMPOSITION CUP

PUMCUPS

HERE'S WHAT *We* MEAN BY—

Miniature BEARINGS!



Type CI Pivot Type Ball Bearings .043"-OD.

Smallest Ball Bearing Ever Manufactured Commercially

An RMB *First*

These bearings, developed by RMB, are not toys. Type C1, and the other ten sizes in the C series, are hard-working components of—

- Delicate Instruments
- Small Motors
- Scales and Gauges
- Small gear trains for clockwork
- Vibration Pick-ups
- Aircraft Instruments

—anywhere a miniature bearing is needed to reduce friction, where space is at a premium. **Bring your miniature bearing problems to RMB.** A complete line of over 250 miniature and instrument bearings including radial and roller types available for prompt delivery. Experimental quantities from stock.

Write for Catalog 11

RMB LANDIS & GYR, INCORPORATED

45 West 45th St. • New York 36, New York

NEW developments in air-line filters by NORGREN

• improved filtering and draining
• wider range of applications

Filtering air in lines leading to power tools, cylinders and other air-operated equipment is essential for proper operation of the equipment and minimum maintenance costs. Norgren Filters have been used as standard by hundreds of manufacturers for efficient removal of corrosive moisture and abrasive foreign matter.

Now, Norgren has made additional mechanical refinements for even better filtering action...has extended the line to cover more applications.

Model 11,200-2

Automatic-Drain Filter, transparent bowl. Flow: 0 to 35 cfm; pressure: 30 to 150 psi; temperature: 40° to 120° F. Choice of 3 filter elements: 200 mesh (74 micron) monel screen, 25- and 64-micron sintered metal. Drain operates automatically under constant or fluctuating air pressure, with or without air flow.

Transparent bowl filter, ¾" and 1" Flow: 0 to 140 cfm; pressure 0 to 150 psi; temperature; 40° to 120° F. Choice of 3 filter elements: 200 mesh (74 micron) monel screen, 25- and 64-micron sintered metal.

Model 22B-6

Transparent bowl filter, ¼" and ⅜" Flow: 0 to 30 cfm; pressure: 0 to 150 psi; temperature 40° to 120° F. Choice of 3 filter elements: 200 mesh (74 micron) monel screen, 25- and 64-micron sintered metal.

Model 12,200-2 (64)

WRITE, NOW, FOR CATALOG SHEETS

C. A. Norgren CO.
3428 SO. ELATI ST., ENGLEWOOD, COLO.

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 25 YEARS

• VALVES • FILTERS • LUBRICATORS • REGULATORS • HOSE ASSEMBLIES

Introducing . . .

HOLTITE NYLOK SCREWS

ONE-PIECE SELF LOCKING SCREWS AND BOLTS

. . . *SAVES YOU TIME AND MONEY!*

Eliminates safety wire, lock washers, jam nuts, and all other locking devices.

The new Holtite-Nylok screws and bolts employ a nylon insert in the threaded section that provides a smooth, positive locking action. Seated or unseated, they lock where stopped.

. . . PLUS THESE EXTRA ADVANTAGES

- Positive Locking
- One piece; eliminates separate auxiliary parts
- Readily replaced
- Interchangeable
- Re-useable
- Locks seated or unseated
- Defies vibration
- No harm to mating thread of parts
- Acts as a seal for gases and liquids under high pressures

HERE'S WHY HOLTITE-NYLOK LOCKS SECURELY

OW NYLOK LOCKS

Resilient Nylon plug (A) sets up lateral thrust, smoothly wedging mating threads together (B). All of locking action is on the threads; head is not stressed. Locking is positive seated or unseated.

(Patented)

YOU CAN ALWAYS COUNT ON CONTINENTAL'S ENGINEERING SERVICE

As Holtite-NYLOK fasteners are presently intended for specific applications, our engineers welcome the opportunity to study your individual requirements and make recommendations for the most efficient and economical applications.

Why not check your own assemblies today. There's a good chance Holtite-NYLOK can boost your output, and save you money.

CONTINENTAL SCREW COMPANY

NEW BEDFORD, MASSACHUSETTS, U. S. A.

CONTINENTAL'S PROOF BOOK

H. I. FRIEDAUF, JR.
He has been with the Pyrene organization for 23 years; member of the National Association of Purchasing Agents; President for 4 years of the Furnace Brook Club, Greenwood Lake, N. Y.

Pyrene Manufacturing Company
AFFILIATED WITH C-O-TWO FIRE EQUIPMENT COMPANY
560 BELMONT AVENUE
NEWARK 8, NEW JERSEY

July 30, 1953

Continental Screw Company
New Bedford, Massachusetts

Gentlemen:

Like most companies we are interested in the things that save us time and money.

In this respect the supplying of HOLTITE taped screws has saved considerable, both in labor and the cost of the envelopes in which they were placed. These are provided for the wall brackets which are packed with our fire extinguishers.

In addition the printing of our Pyrene trade mark on each tape of screws, whether two or more, is an advertising advantage.

We are pleased with the efficient manner in which you have handled our orders and thank you for bringing this improved way of supplying screws to our attention.

Cordially yours,
PYRENE MANUFACTURING COMPANY
H. I. Friedauf
Purchasing Agent

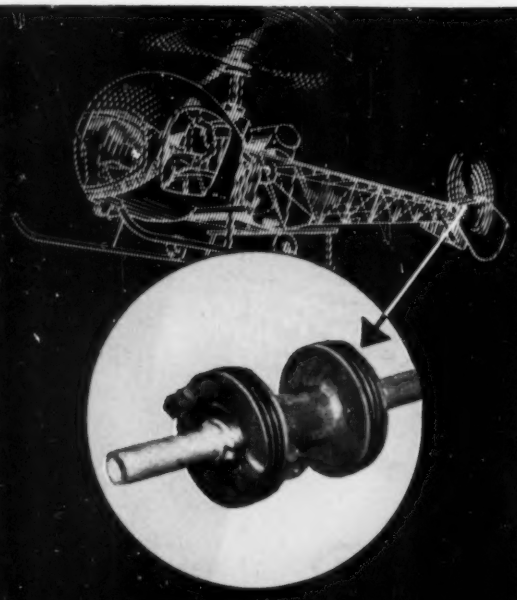
H. I. FRIEDAUF / jr

You too can count on Continental®

CONTINENTAL SCREW COMPANY INC. 1904

Manufacturers of HOLTITE Fastenings For Every Purpose

CONTINENTAL SCREW COMPANY, NEW BEDFORD, MASS., U. S. A.



easier assembly... economical maintenance... with Linear "O" Rings

Linear O Rings perform an unusual job in Bell Aircraft helicopters. The bearing in the tail rotor drive was supported in a metal housing which, because of the metal-to-metal fit, was extremely difficult to install and remove.

By using Linear O rings for mounting the housing, replacement is made easier, maintenance simpler and less costly and a neater, more satisfactory installation is provided.

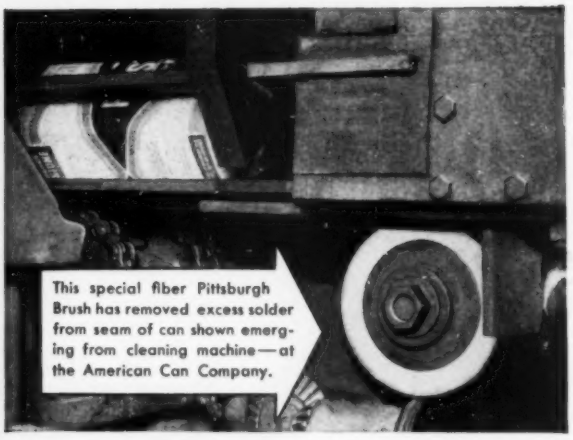
In many other parts of the helicopter, Linear O Rings provide tight-fitting, space-saving seals.

Whenever you need a fool-proof seal, why not consult the Linear Engineering Staff. Write or call Linear today for full information.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.



This special fiber Pittsburgh Brush has removed excess solder from seam of can shown emerging from cleaning machine—at the American Can Company.

"Wouldn't be without them!"

say the men who use . . .

Power-driven Pittsburgh Brushes for longer life, better work!

Last longer, much safer—Cloth brushes formerly used at the American Can Co., Jersey City, to wipe excess solder from can seams lasted less than an hour, occasionally caught fire. Switching to special fiber Pittsburgh Brushes, American Can now gets better than 15 hours life per brush and the fire hazard has been eliminated. Supervisory personnel reports: "We wouldn't be without them!"

Last longer, do better job—In producing wall and ceiling panels, at the Barclay Manufacturing Co., New York City, dust caused by routing "mortar lines" settles on the panels, must be completely removed before panels can be bake-finished. Brushes originally used had a short life span, wore unevenly, and did so poor a job that many baked panels had to be completely refinished to pass inspection. Since even a "fairly good" brush would not do, Barclay searched for the "perfect" brush—and chose Pittsburgh! Result: Better work, and costly refinishing eliminated.

Last longer, better constructed—The Windalume Corporation, Kenvil, N. J., manufacturers of aluminum windows, uses Pittsburgh wire brushes to remove burrs caused by milling. The wire bristles on the brushes used formerly broke off easily. Windalume replaced them with Pittsburgh Brushes because they are better constructed—and Pittsburgh Brushes last longer!

WRITE TODAY FOR FREE BOOKLET!

Write today for a free copy of our booklet that shows, through actual case histories, how Pittsburgh can help cut *your* brushing costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-6, 3221 Frederick Ave., Baltimore 29, Md.

PITTSBURGH

Power Driven

BRUSHES

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS • FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

IN CANADA: CANADIAN PITTSBURGH INDUSTRIES LIMITED

Aeroquip

REG. TRADE MARK

"little gem" FITTINGS

aeroquip did it again!
Another Important Development
in Detachable, Reusable
Hose Fittings!
KNIFE-LIKE SPUR separates hose inner tube and reinforcing wire braid during assembly.
CLAMPING ACTION, between nipple and socket, is exerted on reinforcing wire braid only.
POSITIVE LIP SEAL is formed by end of inner tube in annular chamber.

Here's another great Aeroquip first . . . *"little gem"* Fittings with radically new features never before seen in the industry! These amazing new fittings were especially designed to prolong the life of certain types of hose made of rubber or rubber-like materials, and plastics. Under extreme compression these materials tend to take a definite set and flow away from the zone of compression. This action is accelerated by heat. Through advanced research, development, and engineering, Aeroquip was able to provide the answer to this problem. *"little gem"* Fittings are now in production for Anti-Icing Hose Lines used on aircraft jet engines, and Steam Hose Lines in the industrial field.

"little gem" is an Aeroquip Trade Mark

AEROQUIP CORPORATION, JACKSON, MICHIGAN

SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA.
MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

To users of phosphate coatings,

Pennsalt offers the

New

FOSBOND

A complete system linking together supplies and operations . . .

a complete set of compounds...

for cleaning, pickling, phosphating, and rinsing . . .
all from one reliable source—Pennsalt

applied in a balanced cycle...

tailor-made by Pennsalt engineers to fit your
operations and equipment

serviced and maintained...

by experienced field servicemen on a
regular, scheduled basis

advertised and merchandised

to help pre-sell your quality finish
to wholesalers, dealers, and consumers

At Pennsalt's famous Whitemarsh Research Laboratories, where Fosbond was developed, there are unusually fine testing facilities at the disposal of manufacturers using the Process.

Process

for trouble-free processing . . . for a better, longer-lasting finish

Now Pennsalt, long a pioneer in the metal processing field, offers everything you need for uniform, trouble-free phosphating of steel and zinc!

Products and processing have been engineered to (1) provide an excellent pre-paint corrosion resistant surface, (2) offer simplified operation through the entire balanced cycle, (3) be usable with standard equipment, and be compatible with standard organic finishes.

Every product and technique now offered has been fully field-tested for two years or more. Experienced Pennsalt specialists are ready to come into your plant to show you how to get the most from this advanced system. Furthermore, once the cycle has been introduced in your plant, these men will continue to help you maintain a trouble-free system.

There is no fee for the Process. Reasonably priced chemical products are your only expense.

How's this for proof?

To prove what we say about the Fosbond Process, we offer this service: tell us (1) type of metal to be coated, (2) kind of phosphate coating now used, (3) method of application to be used, (4) kind of organic finish to be employed, and (5) conditions which finish must meet. In turn, we will supply either panels coated by means of the Fosbond Process, or Fosbond chemicals for your use in preparing panels. Then, subject these panels to whatever tests you wish . . . and *you* be the judge.

Which of your products and operations can benefit from the Fosbond Process? Give us details on these items; we'll be able to answer your questions more specifically. Write to Metal Processing Department, 422 Widener Building, Philadelphia 7, Pa.

Finish locked on with FOSBOND Corrosion resistant undercoat

A better start for your finish

Pennsalt Chemicals

PENNSYLVANIA SALT MANUFACTURING COMPANY

A Valuable Fosbond Extra!

The Fosbond Process has received the famous *Good Housekeeping Guaranty Seal.* Manufacturers who qualify may affix to their products the colorful Fosbond emblem which incorporates the Good Housekeeping seal. To help Fosbond users get full advantage from this merchandising "plus", the Fosbond story is told in ***The Saturday Evening Post, Good Housekeeping, U.S. News & World Report, Business Week, Electrical Merchandising, Department Store Economist, Implement & Tractor,*** and ***Office Appliances.***

HARTWELL

sets a new pattern for the future with

Push Button Flush Latches

H-4100

Improve LATCHING Performance! Go Modern with HARTWELL Flush—Self-Closing—Easy to Operate—Simple to Install

Latch is operated by a natural rotation of the hand for push-and-lift positive action. As the forward button is depressed, the rear button raises, providing a sturdy grip for opening the door.

Your need for efficiency and economy today finds a powerful ally in the *Flush Latch* and *Hinge* talents of HARTWELL. Here is the latest *"push button"* method for solving your *flush* latching problems.

Write for engineering specifications and counsel.

HARTWELL COMPANY

Manufacturer of Flush Latches and Hinges, Fittings and Cable Terminals.

9035 Venice Boulevard, Los Angeles 34, California

THERE'S A LESSON HERE ON CHOOSING MOTORS

—don't try to make a standard motor stretch when the job calls for a Wesche Special Motor.

Most powering jobs can be solved satisfactorily with some kind of standard motor. Wesche is in business to solve the tougher problems that call for a specific combination of features. You tell us what the job requires and we design and build the motor that will do it—and go on doing it year after trouble-free year.

Our catalog includes a simple data sheet that can be filled in easily and quickly to give us all the facts we need to quote.

Send for your FREE COPY Today.

THE B. A. WESCHE ELECTRIC CO. (Welco)

1624 VINE STREET • CINCINNATI 10, OHIO

how Cindus X-Crepe® helps micarta® "take the bends" in plastic sink tops

Today, MICARTA, manufactured by Westinghouse Electric Corporation, is fabricated into thousands of sink tops—*without* seams, cracks or metal strips. Because of all-directional-stretch X-CREPE, the decorative plastic MICARTA is a *single, continuous surface—from the top of the splash board to the front edge.*

Before X-CREPE, decorative plastics—table and sink tops, furniture veneers—were limited to flat surfaces. Forming interior arcs and rounded edges was impossible. Non-stretchable paper corestock, used as a saturating base, cracked or split when efforts were made to form it. Corners were made by joining two separate pieces in hard-to-clean, food gathering coves.

Sheets of stretchable CINDUS X-CREPE, saturated with phenolic resin, are pressed, under heat, into a single flat sheet, ready for subsequent forming. Now, X-CREPE's all-directional stretch really comes into play. The flat sheet is reheated and formed—bent into the shapes desired—without cracking or breaking.

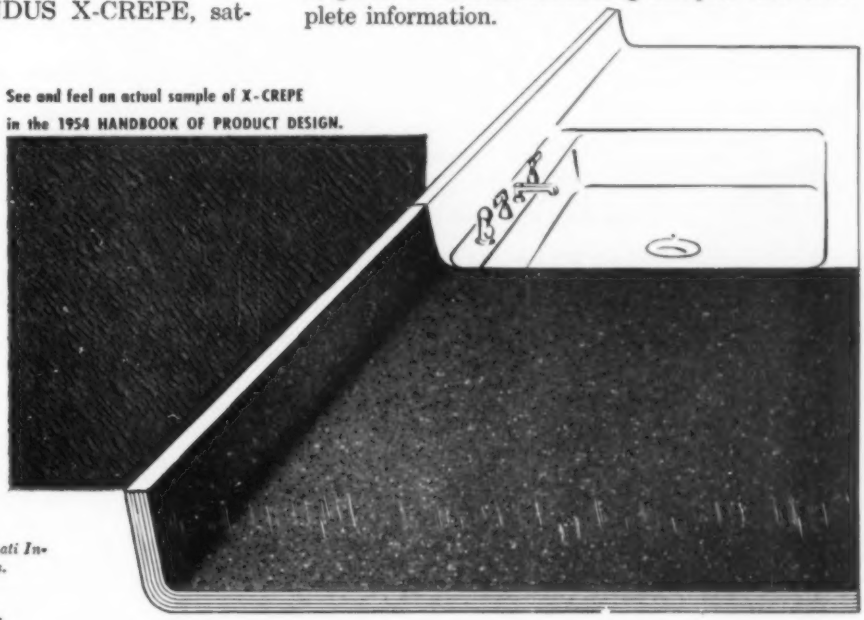
In a simple or compound curve, X-CREPE's formability gives top performance at lowest cost.

This example is typical of hundreds of cases where manufacturers have standardized on X-CREPE because it fills a wide variety of needs better and more economically than less versatile materials. We can tailor X-CREPE to fit *your* needs.

Write today for your FREE CINDUS Design Engineer's Portfolio containing samples and complete information.

X-CREPE® is stretchable, pliable, formable. It can be impregnated, coated, laminated—or combined with cloth and fibers, films and foils to extend the use of such materials far beyond their usual limits. It can be used like cloth . . . instead of rubber . . . in place of cork . . . and for jobs where no other material will do— Available in a wide range of basis weights — sheets, rolls, die-cut shapes, bags and liners.

See and feel an actual sample of X-CREPE in the 1954 HANDBOOK OF PRODUCT DESIGN.



® X-CREPE is the trademark of Cincinnati Industries, Inc., for its double-creped products.

Write today for your FREE CINDUS Design Engineer's Portfolio containing samples and complete information.

CINCINNATI INDUSTRIES INC.
332 Carthage Avenue
Cincinnati 15, (Lockland) Ohio

☐ *Please send me my FREE CINDUS DESIGN ENGINEER'S PORTFOLIO.*

☐ *Please have representative call.*

Name _____

Title _____

Company _____

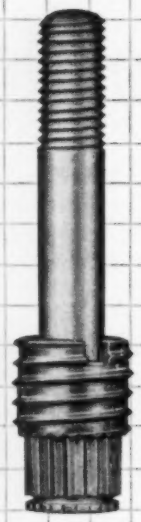
Address _____

City _____ *State* _____

cindus
TRADE MARK

CINCINNATI INDUSTRIES INC.
332 CARTHAGE AVE., CINCINNATI 15, (Lockland) OHIO

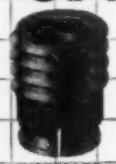
INSERTS DESIGNED BY SPECIALISTS



Series SR Studs

—CAST-IN—
Series NP "Nico-Lok"
Self-Locking Replaceable

—CAST-IN—
Series NN Self-Locking



—INSTALLED—
Series NAR Regular
& Self-Locking

—CAST-IN—
Series RNB Replaceable

DO A BETTER JOB...

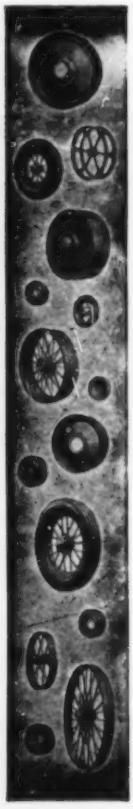
When the job calls for threaded inserts, there is one *right* answer... Newton*. Threaded Steel Inserts and Studs. Designed by men who are specialists in the field, produced in a factory devoted to the manufacture of the world's finest fasteners, Newton Regular and Self-Locking Inserts and Studs are built to give longer, stronger service, lower cost and with a minimum of installation time. No matter what your application problem may be, a Newton Engineer is ready to assist you. Write today for information on the full line of Newton cast-in and installed type Inserts and Studs.

*Patents Pending

Newton Inserts and Studs are specified for practically all modern aircraft and in missiles, rockets, gyros, radar and jettisonable tanks.

1321 EAST 17TH STREET
LOS ANGELES 21
CALIFORNIA

Newton Insert Company



FOR FARM AND INDUSTRY

ELECTRIC

WHEELS ARE RIGHT

Over 65 years in wheel manufacturing have given us the "know how"—modern production methods assure long life and efficient wheel performance in the field.

There is an ELECTRIC spoke or disc wheel for most types of portable equipment. Axles are available where required.

Our experienced engineers are ready to assist you in solving your wheel and axle problems and we will offer our recommendations upon receipt of your specifications.

WRITE FOR CATALOG

ELECTRIC WHEEL CO.

2816 CHERRY, QUINCY, ILL.

Imperial

THE *Finest*

TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

STAINLESS STEEL FOR BUILDINGS

McLouth STAINLESS Steel

For the product you make today and the product you plan for tomorrow.

McLouth Steel Corporation
DETROIT, MICHIGAN
Manufacturers of Stainless and Carbon Steels

GLUTTONS
for
PUNISHMENT

CORNISH

CUSTOM
CORD SETS

Designed, engineered and produced to YOUR specifications

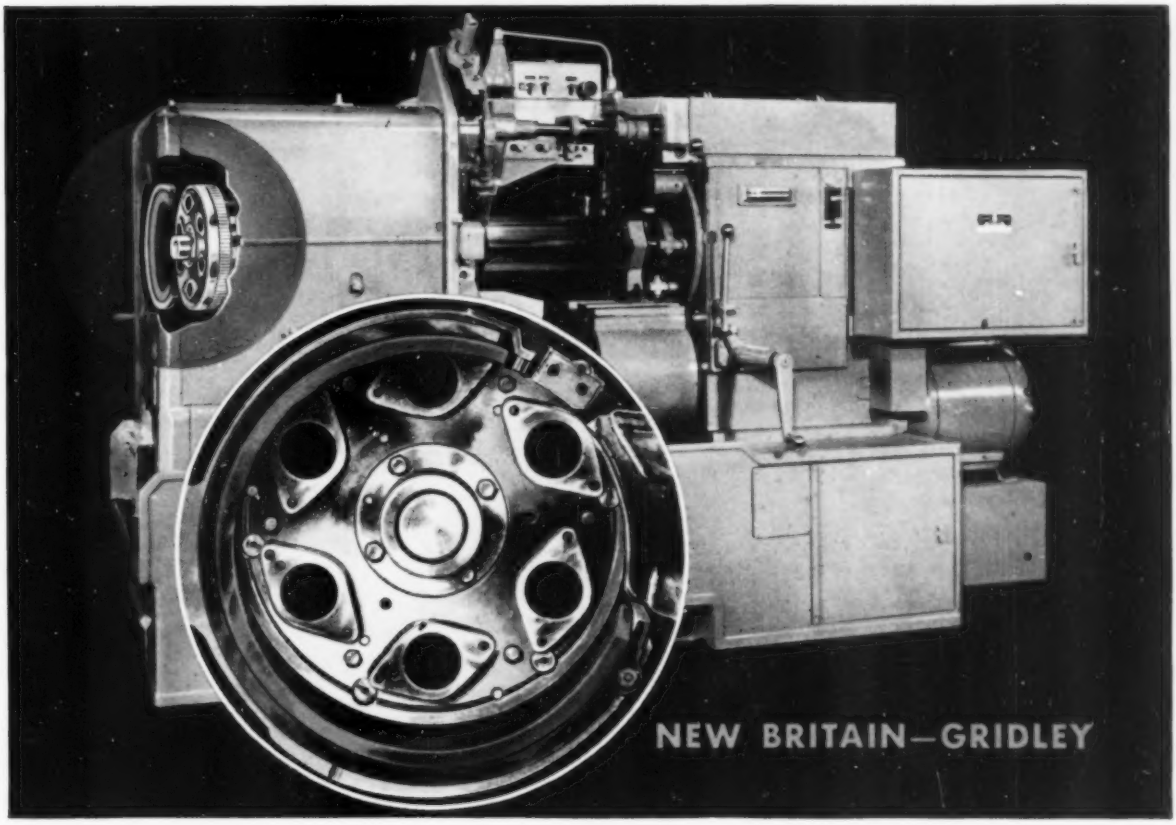
No matter how fierce a beating your wire units must take . . . no matter how different your requirements may be . . . let our experienced staff help you work out the solution. Consult us without obligation.

"Made by Engineers for Engineers"

CORNISH WIRE COMPANY, INC.
50 Church Street **New York 7, N. Y.**

◆ATLANTA BOSTON BRIDGEPORT ◆CHICAGO CINCINNATI CLEVELAND
◆DALLAS DETROIT DENVER KANSAS CITY ◆LOS ANGELES ◆MINNEAPOLIS
◆PHILADELPHIA ◆ROCHESTER ◆ST. LOUIS ◆SAN FRANCISCO ◆SEATTLE

◆*Stock carried*



CAST CENTRIFUGALLY for soundness and uniformity

And economy, too! N.B.D.'s ability to produce quality copper-base castings helps New Britain-Gridley keep permanent accuracy in its automatic screw machines.

This New Britain-Gridley six-spindle automatic screw machine is built to assure continuous production on the toughest jobs without the necessity of frequent adjustment or overhauling.

The function of the stock feed guard ring (shown above) made by National Bearing Division is to keep the six stock feed tubes in proper position while bar stock is being machined and the spindle carrier is being indexed. The stock feed tubes each have a spool which rides on the guard ring. Spindle speed on some machines reaches 2750 rpm. The spindles, indexed into six positions around the circumference of the ring, require close tolerances on the guard ring so that the bearing area will remain uniform.

National Bearing Division was entrusted with the production of this vital component because of its skill in producing centrifugal castings with high physical characteristics, in addition to the economies that could be realized through the purchase of a semi-machined part. National Bearing produces tool slide bushings for these same machines centrifugally cast to the same degree of accuracy and soundness.

If your product requires copper, bronze, or other copper-base castings, it will be worthwhile for you to investigate National Bearing Division. We produce copper-base castings, large or small, with any degree of finish, to precision specifications. And, because we are set up for production runs, we can probably save you dollars.

Write to National Bearing Division for complete information and your copy of our catalog.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

4932 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

EXTRUDED SHEETS

This rich looking, reinforced sheet is a Tenite extrusion by Midwest.

- Advertising displays and signs
- Automotive products and parts
- Aircraft engines and parts
- Premiums, toys and novelties
- Boats and marine equipment
- Refrigeration and appliances
- Radio and television equipment

For better quality end products, use Midwest extruded sheeting . . uniformly high in dimensional stability . . easily worked and formed.

Cellulose acetate, high impact polystyrene other thermoplastic materials extruded precisely to your specifications. Available in clear and colored transparents, translucents and opaques. Also tubes and shapes.

Test our modern engineering and manufacturing methods. Let us prove to you that there are two types of extruded thermoplastics . . . Midwest . . . and All the Rest.

FOR BETTER QUALITY END PRODUCTS

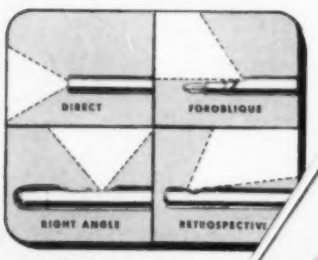
SEND FOR ILLUSTRATED BROCHURE AND PRICES

MIDWEST PLASTIC PRODUCTS COMPANY

1801 CHICAGO ROAD, CHICAGO HEIGHTS, ILLINOIS

A.C.M.I. BORESCOPES

for close-up visual inspection of internal surfaces and hidden parts



A.C.M.I. Borescopes are available in 4 angles of vision (as above)—in diameters of .120" to 4.00"—in lengths of 4" to 720". Special models for special problems.

A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling. • Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission

Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

If You Use . . . or Can Use
MOULDED OR FABRICATED
RUBBER
In Any Shape or Form

BUMPERS—BUSHINGS
CORKS—GROMMETS
SHEET—SLAB—SPRING
VACUUM CUPS—GASKETS
CYLINDER—WASHERS
SHEET—TUBING
EXTRUSIONS
LARGEST STOCK OF SPONGE IN U.S.A.

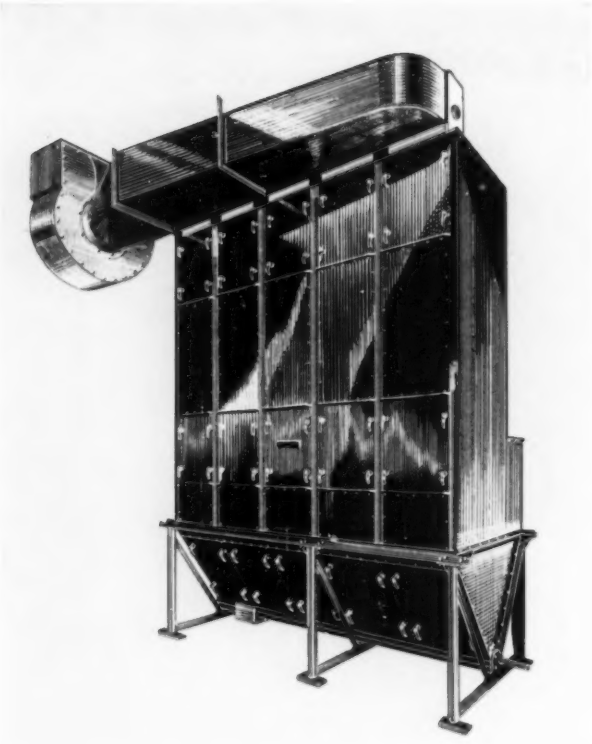
3 decades of experience plus unexcelled laboratory and engineering service is at your command.

ATLANTIC's new comprehensive catalog is now available. Write for your copy today. No obligation.

ATLANTIC INDIA RUBBER WORKS, INC.

571 West Polk Street • Chicago 7, Illinois • HArrison 7-8290

Peerless
PREMIUM-BUILT
ELECTRIC MOTORS
KNOWLEDGE
SKILL
SERVICE
RESPONSIBILITY
A.D.
THE Peerless ELECTRIC COMPANY
1893
POWER
Peerless Motors have a special power you should know about . . . a power that builds reputations.
Tho men who build, sell and service America's finest mechanical equipment know what we mean. They know the value of a motor expertly designed for its job . . . a motor that looks and acts like an integral part of the machine it drives. These men know, too, the importance of service. They respect the efficient, friendly way Peerless Engineers handle difficult problems of application and supply.
Yes, Peerless Motors carry a special premium . . . the Peerless name . . . a name that for 60 years has stood as a symbol of quality and performance.
STANDARD AND SPECIAL MOTORS
BUILT TO SPECIFIC DUTY REQUIREMENTS FOR QUALITY EQUIPMENT MANUFACTURERS.
Since 1893
MOTORS FANS BLOWERS
THE PEERLESS ELECTRIC COMPANY
Peerless Electric



Simon Suction Filter Dust Collector manufactured by Safety Car Lighting and Heating Co., Inc.

To reduce maintenance shut-downs

SPONGEX

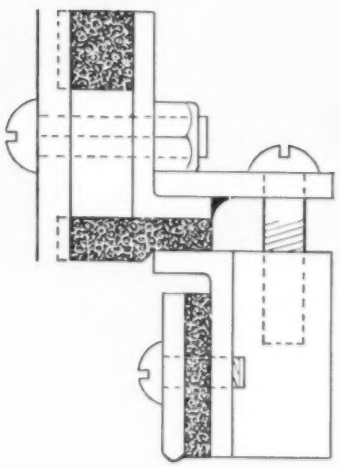
CELLULAR RUBBER

makes longer lasting gaskets

Replacement of even a small gasket on units like this dust collector necessitates a shutdown just as much as a major repair. That's why Spongex cellular rubber gaskets were chosen to seal the intake filter.

Compounded to resist aging, the Spongex seal is long-lasting . . . needs less replacement. Resilient, it forms a firm, tight seal to prevent the escape of the collected dust.

Whether your sealing problem is to keep dust in, or to keep dust out—or if it concerns water, air or temperatures—check with us. Perhaps simple strips cut from economical Spongex Sheet like this or *some* other form of Spongex cellular rubber can do a better job for you.



Cross-section shows how Spongex strips seal filter opening.

SPONGEX® Cellular Rubber

FOR cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY

602 Derby Place, Shelton, Conn.

DOW CORNING

Silicone News

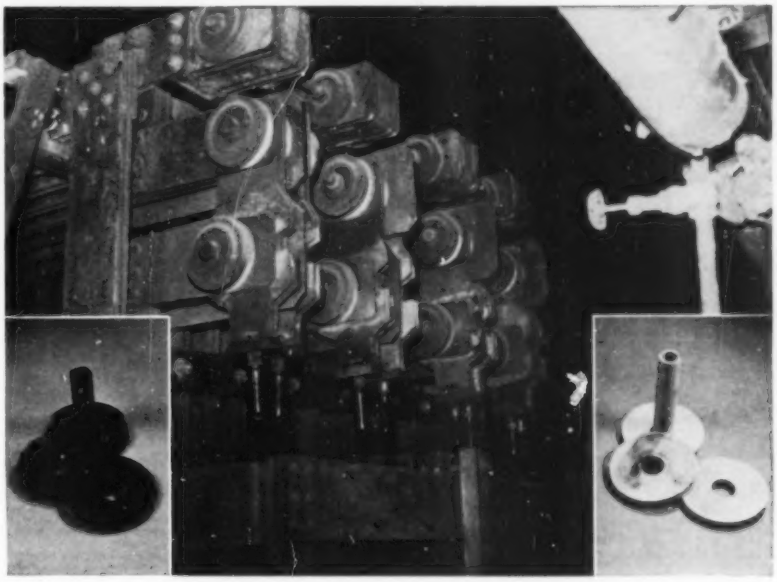
Vol. 1, Number 2 • PUBLISHED BY DOW CORNING CORPORATION, MIDLAND, MICHIGAN

Modified Silicone Finish Used On Vehicle Heaters For Its Superior Heat And Salt Spray Resistance

Heaters manufactured for use in Ordnance vehicles by the Southwind Division of Stewart-Warner Corporation must withstand temperatures far higher than those involved in civilian applications. In the process of selecting the best finish for these units, the relative heat and corrosion resistance of organic and modified silicone paints were severely tested. The photograph shows the results.

The heater shell at left was sprayed with a modified silicone paint which is formulated by Midland Industrial Finishes, and baked for 30 minutes at 400 F. A similar unit, at right, was sprayed with conventional olive drab (TT-E-485b), and baked for 45 minutes at 250 F. Panels in the foreground illustrate the appearance of both finishes before testing.

Both shells were held at 500 F for 4 hours. The conventional finish was then exposed to salt spray for 100 hours. The modified silicone finish was similarly exposed to a salt spray for 300 hours or three times as long. The organic finish was stained, faded, and badly disintegrated, while the silicone coating remained virtually unchanged. As a result, Stewart Warner specified the modified silicone finish for all such heaters. *No. 11*



Silicone Switch Spacers Serviceable After 30 Months; Organic Spacers Lasted Less Than 1 Month

Thirty days was the maximum service life obtainable with cotton-phenolic spacer disks and tubes used to insulate the knife switches on a 45,000 ampere graphitizing transformer.

The organic insulators shown in the left insert were removed after less than 30 days. Operating temperatures ranging from 400 to 500 F converted them to charred, cracked, shrunken conductors. Constant shrinkage required daily tightening of switches; kept maintenance costs up. Replacement meant loss of an entire day's production.

The silicone-glass spacer disks and tubes shown at right were examined during a routine shutdown after 11 months' service. They were in excellent condition and the switches had never required tightening. At that time the silicone-glass laminates had already repaid many times their original cost by increasing production, reducing maintenance costs and down time.

Again, after 30 months of service these silicone-glass laminates were inspected and found to be in very good condition. Insulation value was still high and switch tightening had been virtually eliminated.

Electrical insulating materials coated, impregnated or bonded with Dow Corning silicone varnishes and resins give electrical engineers unprecedented freedom in design; save copper; permit substantial reduction in size and weight of electric machines. They give maximum overload protection; provide maximum life and reliability in spite of overloads, high ambients and humid or corrosive atmospheres; substantially eliminate fire hazard caused by failure of conventional insulation. *(continued pg. 2)*

Silastic* Die-Tips Give Long Service In Hot-Stamping Plastic Ornaments

Mass production of the multi-colored ornaments common to even the least expensive automobiles, is accomplished by hot-stamping pigmented foil to the molded plastic parts.

A problem in developing the process was to find a resilient die-tip material. Mass production techniques required that the material should not stick to the foil at surface temperatures in the range of 500 F, and remain resilient after thousands of impressions at such elevated temperatures. After trying many materials, the problem was solved with Silastic by the Bay Manufacturing Division, Electric Auto-Lite Co. The same Silastic tips have been in use for more than 3 years, and none of them has worn out, lost its flexibility or peeled from its metal backup plate.

The heat stability and aBhesiveness characteristic of Silastic have proved to be equally useful in other similar applications. Silastic-coated pressure plates, backing bars or press pads are used in printing or sealing plastic packaging materials. Silastic rings are used on banding machines to press gold leaf ribbon on cosmetic containers. Silastic-covered rolls are used in the hot or cold dip coating of fabrics, plastic film and metal sheeting or foil. *No. 12*

* T. M. REG. U. S. PAT. OFF.

DOW CORNING Silicone News

NEW DEVELOPMENT AND TECHNICAL DATA

For copies of any of the publications reviewed in this column or for data relating to any of the articles printed in this issue of the Dow Corning Silicone News, simply circle the corresponding reference number on the coupon below.

"Tall Tales and Fabulous Facts" is a new 24-page booklet in which a parallel is drawn between the tall tales our ancestors told about such legendary characters as Paul Bunyan, Davy Crockett and Pecos Bill and some of the equally fabulous facts about Dow Corning silicone products. *No. 15*

•

Use of bare magnet wire coated with new Dow Corning 1360 Wire Enamel permits operation of small electric machines and electronic parts at 180 C. Flexibility, scrape hardness and dielectric strength compare favorably with those of the best organic wire enamels. Life expectancy at 180 C is in the range of 50,000 hours compared with 200 hours for wire insulated with conventional enamels. *No. 16*

•

Pharmaceutical properties of Dow Corning 200 Fluids are described in a recent reprint from the Journal of American Pharmaceutical Association. This article includes a study of compatibilities with acids, alcohols, waxes and commercial ointment bases. *No. 17*

•

"Silicones Help Convair B-36 Fight Cold." This reprint of an article from Aviation Week describes and illustrates various nonrestricted applications for Silastic and other Dow Corning Silicones in one of the largest aircraft, operating at temperatures ranging from —100 to +500 F. *No. 18*

•

Current Aeronautical Material Specifications and SAE ASTM Specifications for silicone rubber are outlined in a data sheet which also lists the Silastic stocks which meet these specifications. Handy reference for any design engineer working on military projects. *No. 19*

•

Now available, the new 1953-54 Reference Guide to Dow Corning Silicone Products summarizes properties and briefly describes applications for commercially available silicones. Indexed for easy reference. A "must" in every designer's catalog file. *No. 20*

•

New Antifoam A Spray bomb instantly defoams many of the most violent and persistant foamers. Spray consists of Dow Corning Antifoam A combined with Freon propellent and is effective in concentrations as low as 0.1 to 1 ppm. Now available from laboratory supply houses. *No. 21*

DOW CORNING CORPORATION - Dept. RI-10
Midland, Michigan

Please send me: 11 12 13 14 15 16 17 18 19 20 21

NAME _____

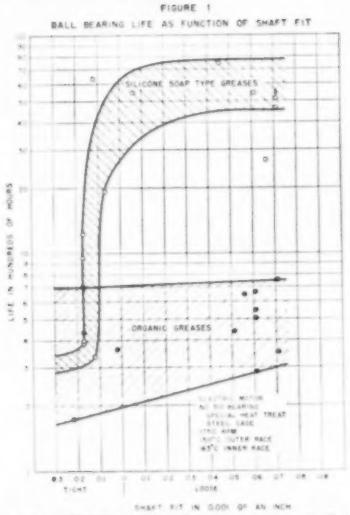
COMPANY _____

TITLE _____

CITY _____ ZONE ___ STATE _____

Bearings Fitted To Compensate For Thermal Expansion Further Extend Service Life of Silicone Grease

In electric motors which may operate hot, the mechanical fit-up of the bearing assembly has a critical effect on the life expectancy of silicone grease. This was proved by the life-testing of various greases in the bearings of totally enclosed nonventilated induction motors operating at high temperatures. The relation between shaft-fit and life in hours is shown in Figure 1.



In the TENV induction motors used to test bearing life at 150 C, these curves indicate that the life of Dow Corning 44 lubricated bearings with a shaft-fit of 0.2 mils loose is about 15 times the life of identical bearings with a shaft-fit of 0.2 mils tight.

These data show the importance of mechanical fit-up. A tight shaft-fit, for example, may take up most of the radial clearance in the bearing. Where the inner race operates at a higher temperature than the outer race, unequal thermal expansion may put the balls under compression. Any combination of mechanical fits which produces radial clearances inadequate at operating temperatures, or poor bearing alignment, will subject the grease to extreme pressures and result in unsatisfactory bearing life.

The test data also showed that an end play of at least nine thousandths of an inch was effective in extending the service life of silicone grease lubricated bearings.

The subject of Design Considerations for Optimum Performance of Silicone Greases in Ball Bearings is more fully developed in a paper read before the ASLE. *No. 14*

KNIFE SWITCH SPACERS *continued*

These advantages were inherent in the first silicone resins and varnishes introduced over ten years ago by Dow Corning Corporation. Since that time many improvements have been made and new silicone dielectrics are constantly being introduced by our research chemists and product engineers.

For example, Dow Corning 2105 is a relatively new silicone product for making silicone-glass laminates that retain a dielectric strength of 180 volts per mil after 5000 hours at 250 C. That's approximately 100 times the dielectric life of the best laminates previously available. This new resin exhibits slight thermoplasticity at elevated temperatures, but not enough to limit its use in most applications where maintenance of dielectric strength is of importance.

The following table compares typical physical properties of silicone-glass laminates made from ESS 261, washed glass cloth, bonded with Dow Corning 2103 Resin and Dow Corning 2105 Resin. Operating conditions will determine which type of laminate is most suitable for specific applications. *No. 13*

Typical Properties	Laminates of ESS 261 Washed Cloth Bonded with 2103 Resin	Laminates of ESS 261 Washed Cloth Bonded with 2105 Resin
Thickness	⅛"	⅛"
Flexural Strength, psi		
at 77 F	26,500	24,500
at 500 F	10,100	4,200
at 500 F, after aging 100 hr at 500 F	6,400	2,500
Bond Strength, pounds	1,050	1,000
Water Absorption[1], percent	0.150	0.05
Dielectric Strength, volts per mil ⅛" electrodes	85	250
Dielectric Constant[2] at 25 C		
at 10^2 cycles		3.62
at 10^6 cycles	3.88	3.40
Power Factor[2] at 25 C		
at 10^2 cycles		0.0250
at 10^6 cycles	0.0120	0.0036
Arc Resistance	250	280

[1] After 24 hour immersion.
[2] Samples conditioned 24 hr at 25 C prior to testing.

DOW CORNING CORPORATION
First in Silicones
MIDLAND, MICHIGAN
Atlanta
Chicago
Cleveland
Dallas
Detroit
Los Angeles
New York
Washington, D. C.
(SILVER SPRING, MD.)
In Canada: Fiberglas Canada Ltd., Toronto
In England: Midland Silicones Ltd., London

Manufacturers of
Silicone Fluids
Silicone Abhesives
Silicone Adhesives
Silicone Release Agents
Silicone Compounds
Silicone Greases
Silicone Water Repellents
Silicone Bonding Resins
Silicone Electrical Insulating Resins
Silicone Molding Compounds
Silicone Expansible Resins
Silicone Defoamers
Silastic

DESIGNING WITH ALUMINUM

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

NO. 4

CORROSION RESISTANCE

ALUMINUM ALLOYS RESIST ATTACK BY WIDE RANGE OF ENVIRONMENTS, MANY CHEMICAL COMPOUNDS

RESISTANCE to corrosion is a relative matter because it depends on the environment to which a metal is exposed. Aluminum and aluminum alloys have generally excellent corrosion resistance. They withstand corrosive attack by most types of environment, including many which adversely affect the performance of other commonly used metals.

Conditions which cause the corrosion of aluminum are the exception, not the rule. Normally, aluminum lasts indefinitely—bare and unprotected. This fortunate situation occasionally leads to over-enthusiastic use. The user may expect and demand a much higher level of performance from aluminum than he ever has or would from another metal, with resulting improper application or failure to follow good installation practice.

Reason for the good corrosion resistance of aluminum is that the practically transparent oxide coating that forms on surfaces exposed to air is tough, adherent and non-flaking. So, once formed, it is non-progressive and non-destructive, in contrast to oxidation which results in flaking that constantly exposes new metal to attack and so proceeds inevitably towards the total destruction of the metal.

Under most conditions the oxide coating of aluminum thickens within a relatively short time to a point where no further measurable oxidation occurs. It is also self-renewing. Whenever the oxide film is broken, it immediately reforms on exposure to air and again assumes its protective role.

It follows then that the conditions which promote the corrosion of aluminum usually involve the presence of a compound which dissolves or otherwise penetrates this coating, and the absence or exclusion of the oxygen required to rebuild it.

One of the useful properties connected with aluminum is that the electrolytic process known as anodizing thickens and strengthens the oxide coating artificially. Anodizing thus increases resistance to destructive atmospheres and also tends to reduce the possibility of galvanic corrosion. Anodizing is regular commercial practice in many applications and products of aluminum. A coincidental benefit resulting from this process is that brilliant color can be incorporated to obtain highly decorative effects, and frequently it is used for this purpose only. Building up the oxide coating also increases resistance to abrasion.

High purity aluminum is rated as having the best corrosion resistance to chemicals, but this is not always the case with other forms of attack. For instance, in marine atmospheres 52S is superior to high purity aluminum. Most aluminum alloys will generally outlast other metals except under special conditions.

ATMOSPHERIC CORROSION

In general service metals may be exposed to three types of atmosphere—normal (rural, uncontaminated), industrial (urban, contaminated) and marine (moist, salty).

Tests of several aluminum alloys sponsored by the American Society for Testing Materials (Table 1), using the percent change in tensile strength as a measure of corrosion resistance, showed that all the alloys exposed were practically unaffected by normal atmospheres. In industrial and marine atmospheres corrosion was so slight as to be of no significance in practice. This was true even for 24S-T3, copper-bearing heat-treatable alloy. The clad form of this alloy suffered no loss in tensile strength, indicating the effective protection given to the high-strength alloy core by the cladding of higher-purity aluminum.

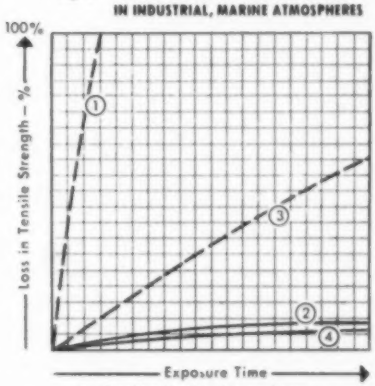
Table 1—EFFECT OF VARIOUS NATURAL ENVIRONMENTS ON ALUMINUM ALLOYS

(% Change in Tensile Strength Resulting from Ten Year Corrosion Tests Conducted by American Society for Testing Materials)

Alloy Type	MARINE			INDUSTRIAL		RURAL	
	La Jolla, California	Key West, Florida	Sandy Hook, New Jersey	New York, New York	Altoona, Pennsylvania	Phoenix, Arizona	State College, Pennsylvania
2S-H14	— 5	—2	—3	—7	—5	—1	—4
3S-H14	— 3	0	0	—4	—6	0	—1
24S-T3	—18	0	—3	—9	—6	—1	—4
Clad 24S-T3	+ 2	+1	+2	+2	0	+2	+1

NOTE: The gains in strength resulting in some cases arises from the fact that the tensile strength of heat-treatable alloys increases with natural aging.

Fig. 1—RELATIVE LOSS OF TENSILE STRENGTH IN INDUSTRIAL, MARINE ATMOSPHERES



1 Steel in Marine Atmosphere
2 Aluminum in Marine Atmosphere
3 Steel in Industrial Atmosphere
4 Aluminum in Industrial Atmosphere

Numerous other tests of aluminum alloys, both wrought and cast, have shown similar results, while steel simultaneously exposed has been virtually destroyed by industrial and marine atmospheres over a period of time. Typical relative loss in tensile strength of aluminum alloys and steel under exposure to marine and industrial atmospheres is illustrated in Figure 1. These test results are verified by the long actual service given by aluminum in buildings and equipment under severe conditions where other materials have required steady maintenance or replacement. A guide to the resistance of a number of aluminum alloys to atmospheric and sea water attack is given in Table 2.

Of importance as well is the fact that aluminum stands up well in contact with most other common building materials. Such attack as may occur is usually limited to superficial etching and minor pitting where dirt accumulates between faying surfaces. Although it has been considered good practice to protect the surface of aluminum where it is in contact with concrete or mortar, protection is really not necessary. Most if not all of any attack, even upon unprotected aluminum, takes place early during the setting period and is so minor as to be

PLEASE TURN TO NEXT PAGE ➡

of no consequence. Maximum penetration of the metal under such conditions probably would not be much over two

Table 2

RELATIVE CORROSION RESISTANCE OF ALUMINUM ALLOYS

Alloy	Non-Industrial Atmosphere	Industrial Atmosphere	Marine Atmosphere or Sea Water Service
2S	A	B	B
3S	A	B	B
4S	B	B	C
50S	A	A	A
52S	A	B	A
Clad 56S	A	B	B
61S	A	A	B
63S	A	A	B
24S	B	C	D
Clad 24S	A	B	C
75S	B	C	D
Clad 75S	B	B	C
43, 214, 356, 360	A	B	B
195	B	C	D

NOTE: Relative resistance — A, best; B, good; C, fair; D, not usually recommended without additional surface treatment. This table is useful only as a general guide.

mils. Where aluminum is in contact with masonry or wood which is continuously or repeatedly wet, it should be protected with a bitumen or similar coating on the contacting surface.

After prolonged exposure to normal air, aluminum surfaces weather, with some loss of the original polish and smoothness. This is seldom more than a superficial condition that can be remedied by simple cleaning.

AQUEOUS CORROSION

Most of the non-heat-treatable aluminum alloys and clad forms of the heat-treatable alloys offer a high order of resistance to corrosion by alternate immersion in sea and harbor waters, where unprotected steel deteriorates rapidly.

Magnesium-bearing alloys such as 50S and 52S are especially resistant to all forms of aqueous corrosion. 52S, strongest non-heat-treatable sheet and plate alloy in commercial use which is noted for its ruggedness, is used extensively in marine applications.

The copper and zinc-bearing heat-treatable alloys such as 14S, 24S and 75S are generally less resistant to aqueous attack, but their performance under salt water conditions is substantially improved by cladding. 61S has better resistance than the other heat-treatable alloys, and is therefore used widely in the bare condition.

CHEMICAL CORROSION

The chemical process industries are large users of aluminum because it resists attack by many chemical compounds. Aluminum in some instances offers the further advantage that the salts of aluminum are colorless, tasteless and non-toxic so that any corrosive products will not adversely affect manufactured products.

An example is the use of aluminum for the manufacture, storage and transportation of glacial acetic acid. There is no contamination, other impairment or coloring of the product by any products which might be introduced through superficial attack.

Table 3

PARTIAL GENERAL GUIDE TO RESISTANCE OF ALUMINUM TO VARIOUS COMPOUNDS

COMPOUND	GRADE
Acetic Acid, Dilute	B
Acetic Acid, Glacial	A
Alcohol, Methyl & Ethyl	B
Ammonia (dry)	A
Ammonium Hydroxide	C
Benzene	A
Boric Acid	A
Bromine	D
Carbonic Acid (dilute)	A
Chloride of Lime (calcium hypochlorite)	C
Chlorine (v.c. with water)	D
Creosote	B
Dichlorodifluoromethane (Freon F-12)	A
Dichloromonofluoromethane (Freon F-21)	B
Dichlorotetrafluoroethane (Freon F-114)	A
Ethylene Glycol	B
Fluorine	D
Freon 11	B
Freon 22	A
Freon 113	B
Gasoline (anhydrous)	A
Hydrochloric Acid	D
Hydrogen Peroxide (30% and higher)	A
Lacquers	A
Lime	B
Nitric Acid (above 80%)	A
Nitroglycerine	A
Olive Oil	A
Oxalic Acid	C
Oxygen	A
Perchlorethylene (dry)	A
Phosphoric Acid	D
Potassium Bicarbonate	A
Potassium Carbonate	C
Potassium Chromate	A
Resins	A
Sewage	A
Sodium Carbonate	C
Sodium Nitrate	A
Sodium Sulfate	B
Steam, Low Pressure	A
Sulfur Dioxide (dry)	A
Toluene	A
Trisodium Phosphate	C
Urea	A
Varnish Solvents	A
Water, Distilled	A
Water, Industrial	B
Water, Rain	A
Water, Sea	C
Water, Tap	C
Zinc Acetate (up to 10% conc.)	A
Zinc Chloride	D

NOTE: Resistance — A, excellent; B, good; C, fair; D, poor.

Aluminum provides excellent corrosion resistance to organic compounds and such chemicals as ammonia, hydrogen sulfide, hydrogen peroxide (30% and higher) and concentrated nitric acid. Solutions of strong alkalis, sulphuric acid, hydrochloric acid, carbonates and fluorides tend to attack aluminum because they can dissolve or penetrate the protective oxide coating. However, the extent of corrosion varies with concentration and temperature and may often be minimized or eliminated through the use of inhibitors. Table 3 provides a guide to the relative chemical resistance of aluminum to a few widely used compounds.

GALVANIC CORROSION

Direct contact with dissimilar metals in the presence of a liquid which might become an electrolyte should be avoided to prevent corrosion of the anodic metal. Metals such as zinc and magnesium are usually anodic to aluminum. It is not always true that aluminum is anodic to steel. For example, in some tap water conditions, particularly where higher temperatures are involved, steel may be attacked in preference to aluminum.

The danger of galvanic corrosion is frequently overrated. Its extent depends on the amount of current flow between dissimilar metals. In turn this depends on the electrical resistance of the space by which the metals are separated as well as the difference in potential.

In most cases galvanic corrosion can be entirely eliminated or reduced to negligible proportions by simple, practical methods. There can be no galvanic corrosion if moisture is excluded or if insulating material increases electrical resistance. The problem is minimized when the anodic area is large in comparison with the cathodic area such as a large area of aluminum and a small area of steel or copper. Innumerable composite steel and aluminum structures have given long life.

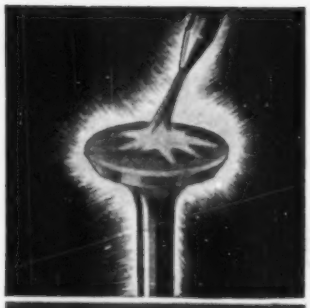
CORROSION PREVENTION

There are numerous ways of protecting aluminum where it is used under circumstances where conditions may be conducive to corrosion. They include painting, artificial thickening of the oxide film through anodizing, formation of other insoluble films, plating or cladding. Where used with aluminum, steel bolts and other fittings should be galvanized or plated with cadmium. Design should avoid corners and crevices where moisture can lodge.

The assistance of Kaiser Aluminum engineers with information on the corrosion resistance of aluminum or on specific corrosion problems or other phases of aluminum application may be obtained by calling any Kaiser Aluminum sales office in the principal cities or by writing Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland, California.

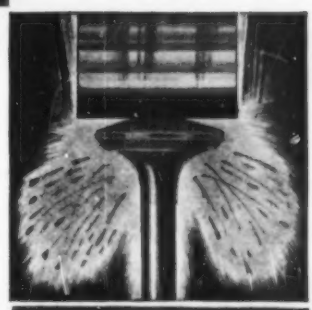
Kaiser Aluminum

setting the pace . . . in growth, quality and service



These facilities ...this special know-how

...may hold ideas YOU can use NOW



Every day the Valve Division is welding thousands of pounds of high-alloy coatings to unusual Thompson-developed alloys to give internal-combustion engine valves added life under super-severe service.

We also insert highly-combustible metallic sodium into hollow valve stems to make engine valves run cooler and last longer.

The Valve Division also knows plenty about forging and finishing extra-tough alloys to precision limits.

If you have out-of-the-ordinary production problems, you'll want to know more about Thompson know-how and facilities. And, if you have ideas about how we can help on new projects, we'd like to talk them over with you.

VALVE DIVISION

Thompson Products, Inc.

DEPARTMENT VE-10 • CLEVELAND 17, OHIO

Got A Hard-To-Reach Place

WHERE YOU HAVE TO PUT A NUT?

use

MIDLAND Welding Nuts

Midland Welding Nuts anchored* to parts in inaccessible places eliminate the need for holding them while attaching other parts.

*THIS IS ALL YOU DO—Just insert collar of Midland Welding Nut in hole for bolt or screw, resistance weld the Nut in place, and the Nut is there for the life of the job. Nuts can be automatically fed to the welder. Speed your production . . . save money.

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Ave. • Detroit 11, Michigan

Export Department: 38 Pearl St., New York, N. Y.

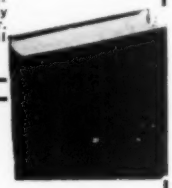
Manufacturers of

AUTOMOBILE AND TRUCK FRAMES | AIR AND VACUUM POWER BRAKES | AIR AND ELECTRO-PNEUMATIC DOOR CONTROLS

ENGINEERING DRAWING

Just Published!

New idea in engineering drawing manuals . . . hundreds of drawings—in a giant, oversized format—show step-by-step all drafting techniques, constructions, projections, and use of instruments. Basic self-teacher in all fundamentals . . . ideal refresher course for technical men. Explains orthographic projection by means of "pictorials" which let you "see" the object in space. Even covers basic shop processes. **By Frank Zozzora, Head of Engr. Draw., U. of Delaware. 361 pp., 628 illus., $5.00**



APPLIED ELASTICITY

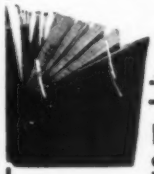
Just Published!

Intended for engineers, this book provides the fundamental knowledge necessary to formulate any problem in the theory of elasticity. It also presents the most useful analytical and numerical methods for solving these problems. Emphasizes the physical meanings of the notations and mathematical relationships occurring in the subject, and discusses in detail the various approximate methods of solution. Covers stress-strain relations, torsion, energy principles, buckling plates and shells. **By C. T. Wang, Prof. of Aero. Engr., N. Y. U. 357 pp., 145 illus., $8.00**

TEXTBOOK of the MATERIALS OF ENGINEERING

Just Published! 8th Ed.

Concisely presents the properties of various materials, used for machine and structural parts, which affect the strength, stiffness, ductility, and resistance to corrosion and wear. Includes methods of production and methods of strengthening materials . . . effectiveness of various treatments. Among topics discussed in 8th edition are resistance to "fatigue" under compressive loads . . . boron and titanium . . . prestressed and air-entrained concrete . . . numerous plastics, etc. **By H. F. Moore, U. of Illinois, and M. B. Moore, Rutgers U. 8th Ed. 370 pp., 140 illus., $6.00**



ENGINEERING STATISTICS and QUALITY CONTROL

Just Published!

A clear, practical treatment of modern statistical methods for cutting costs and stepping up plant efficiency. Reviews fundamental measures—averages, variabilities, efficient calculation—and covers use of normal curves, control charts and their application, acceptance sampling methods—with a special section on applying statistical methods right on the job. Packed with experiments, samples, and problems to point up the text. **By Irving W. Burr, Prof. of Math. and Research Assoc., Statistical Lab., Purdue U. 442 pp., $7.00**

10-DAY FREE TRIAL

McGraw-Hill Book Co., 330 W. 42nd St., NYC (36)

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus a few cents delivery, and return unwanted book(s) postpaid. (We pay for delivery if you remit with this coupon—same return privilege.)

- ☐ Zozzora—**Engr. Drawing**—$5.00
- ☐ Wang—**Applied Elasticity**—$8.00
- ☐ Moore & Moore—**Materials of Engr.**—$6.00
- ☐ Burr—**Engineering Statistics**—$7.00

(Print)

Name .....

Address .....

City ..... Zone... State.....

Company .....

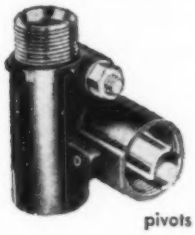
Position PE-10

This offer applies to U. S. only.

Everything's Under Control with **DRIVES** and **TRANSMISSIONS**

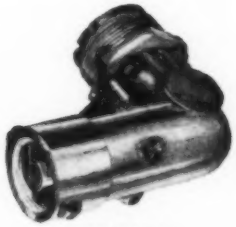
by BREEZE MARK

TEE DRIVE
Precision geared for actuators connected in series



90° ACTUATOR DRIVE
For direct connection to actuator that pivots in trunion mounting

TORQUE TUBE DRIVE
For transmitting torque between torque tube and flexible shaft.



90° DRIVE
Precision gearing, double ball bearing suspension Sealed and lubricated

● To actuate tabs, flaps, shutters and other aircraft mechanisms with positive, precision control, the industry long has relied on Breeze drives and transmissions. From simple mechanical drives and direct reading indicator drives to electrical and hydraulic actuators, Breeze offers a complete line, affording a wide choice of components and assemblies to meet many individual design needs.

Shown here are examples of Breeze-engineered lightweight mechanical drives, having connections to mate with flexible shaft drives. The 90° and TEE drives may be mounted in any position with relation to an actuator mounting.

Inherent in all these designs are features dictated by specific aircraft needs and experience. You may find the assemblies you require in our wide variety, thus saving design and tooling costs. Or, our engineers will design and custom build to your special requirements.

We invite consultation. Write for our complete informative catalog.

BREEZE

CORPORATIONS, INC.

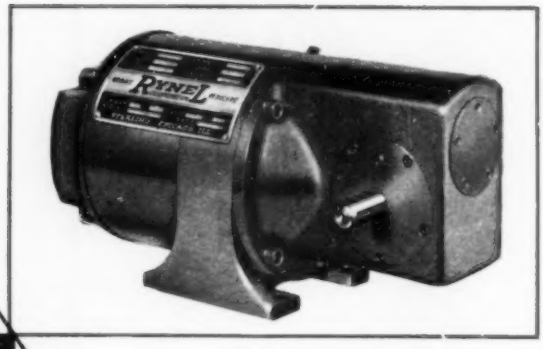
41 South 6th Street, Newark 7, New Jersey

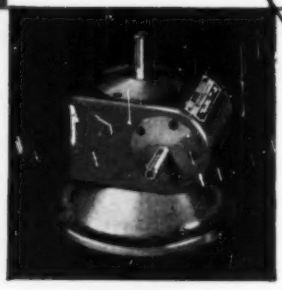
OTHER BREEZE PRECISION PRODUCTS Special Connectors Actuators • Ignition Shielding • Aero-Seal Worm Drive Hose Clamps

POWER TRANSMISSION

DESIGNED FOR THE JOB

GIVES GREATER EFFICIENCY





DESIGNERS AND SUPPLIERS

Double Reduction
Right Angle
Parallel Shaft
Shaft Mounted
Speed Reducers
and
Gearmotors

MEMBER

ENGINEERED RIGHT IN YOUR OWN PLANT

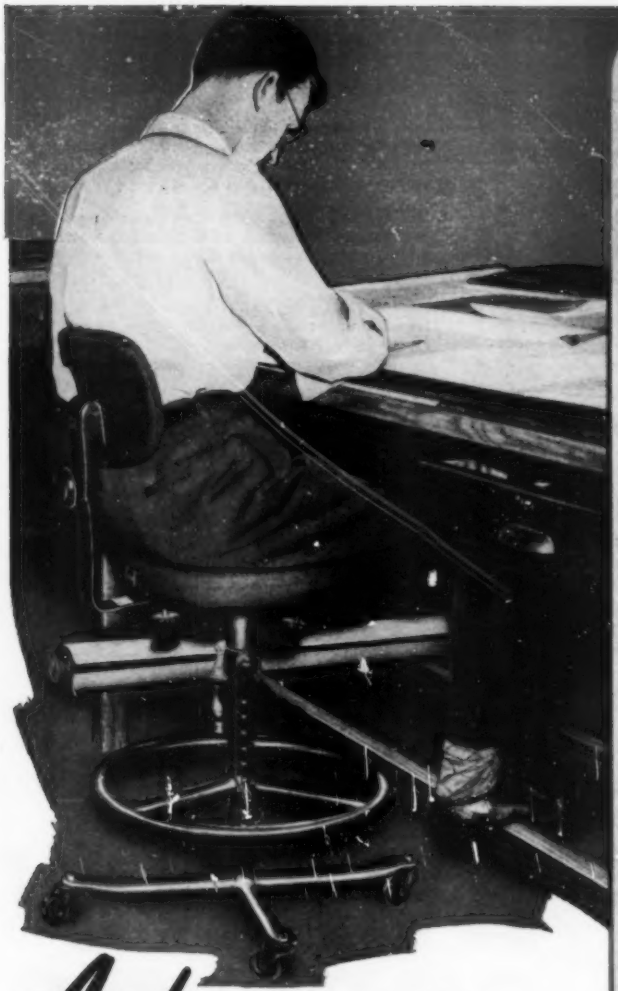
Rynel Design-Engineering Service offers all users of **standard** or **special** power reduction units custom-facilities for efficient power application. Rynel engineers will consult with you right in your own plant. As a result of Rynel's exclusive air-lift, this expert assistance on speed reduction problems is available immediately. You are invited to call a Rynel engineer for consultation.

CALL A RYNEL ENGINEER — STerling 4440

He Will Visit You The Same Day You Call.

RYNEL CORPORATION

712 Miller Street • Sterling, Illinois



OVER 100

Cramer DRAFTING CHAIRS IN USE AT THE STUDEBAKER CORP. SOUTH BEND, INDIANA

Studebaker draftsmen are enjoying a working freedom they never knew before they got their comfortable Cramer Drafting Chairs. These chairs are equipped with a unique tilt feature which lets the worker lean forward into a semi standing position while the seat and back follows his body. A draftsman can reach anywhere on his drawing board and still remain seated! Draftsmen everywhere appreciate the originality of Cramer designed patented posture chairs. Chair originators . . . never imitators.

CORRECT POSTURE INCREASES EFFICIENCY IN ANY PLANT

Ask any Studebaker draftsman how he likes his Cramer "Standing-Sitting" Chair with its comfortable foam rubber seat and back and its easily made adjustments that fit it to his body. He'll tell you that he works faster and better . . . that he doesn't become fatigued. All Cramer Posture Chairs are designed to increase worker efficiency, morale and health. They cut production costs in hundreds of industrial plants from coast to coast.

And... IN ADDITION . . .

Several hundred Cramer Executive Chairs are providing Studebaker office personnel with proper posture, and health-giving, fatigue-free efficiency. They add beauty too . . . have aluminum bases . . . adjust rapidly to size of occupant—without tools!

Partial View of Executive Posture Chair Installation at Studebaker Corporation by Cramer

Cramer SEATING ENGINEERS ARE AT YOUR SERVICE

Cramer installations make use of a large number of different chairs. Special models are available for assembly line workers of all kinds, for jewelers, linotype operators, high bench workers . . . a chair for every seated worker. Special models are often tailor-made for individual requirements. Studebaker fabrics were used on the entire Studebaker installation.

MAIL COUPON TODAY

Cramer POSTURE CHAIR CO., Inc.
1206 Campbell
Kansas City 6E, Missouri

Send me full particulars about the Cramer "Standing-Sitting" Chair and other Cramer chairs.

COMPANY _____

ADDRESS _____

TOWN _____ STATE _____

SEEING is BELIEVING!

To prove it's best, make the Clearprint test

See for yourself why leading engineers and architects from Coast-to-Coast are demanding Clearprint Technical Papers. Ask for a sample, then make this convincing test:

1. **INVITES THE PENCIL**—Try Clearprint's perfect working surface with a 2H pencil, then with a ruling pen. Lines are sharp and clean—no feathery edges.
2. **NO GHOSTING**—Erase some of the lines. Redraw and erase several of them time and again. Crease the paper, too. Then hold it to the light, or make cleanest possible reproductions.
3. **NEVER CHANGES**—Sheets in use for 19 years prove Clearprint's amazing stability. Its strength, transparency and printing qualities remain unchanged after extended exposure to age, atmosphere, heat and light.

If you are not using Clearprint now, please make this comparative test on the paper you are using.

CLEARPRINT®

TECHNICAL PAPER

THERE IS NO SUBSTITUTE—Demand Watermarked Clearprint

SPECIFY: No. 1000H CLEARPRINT—The Universally Accepted Tracing Paper.
No. 1025 PAPERCLOTH—The Paper with Cloth Durability.
Clearprint is available in widths from 24" to 54".
Ask for samples from your dealer, or write:

CLEARPRINT PAPER CO.
1482 SIXTY-SEVENTH STREET · EMERYVILLE, CALIFORNIA

COPPER • MONEL • K-MONEL • BRONZE • CHROME ALLOY • STAINLESS STEELS • GLASS • PLASTICS • ALUMINUM • DRILLED BALLS

Hartford

PRECISION BALLS

Precision balls made for your job. In many materials. Send your specifications to our Engineering Department. Their recommendations will be forwarded to you promptly.

21H548

THE HARTFORD STEEL BALL CO.
HARTFORD 6, CONN.

DETROIT · CHICAGO · NEWARK, N. J. · LOS ANGELES, CAL. · EXPORT

EVANS' SPRINGS

COMPRESSION • TORSION
EXTENSION & SPECIAL
TYPE SPRINGS
METAL STAMPINGS &
WIRE FORMS

SEND FOR SELECTION SHEET
FOR SPECIAL DESIGNS

JOHN EVANS' SONS, INC.
506 NORTH 13th STREET
PHILADELPHIA 23, PA.

All FORMSPRAG CLUTCHES ARE *Full Complement* CLUTCHES

WHAT IT MEANS:

A full complement of sprags is inserted in the annular space between an inner and outer race. Contact with race surfaces is maintained by energizing springs.

WHY IT'S IMPORTANT:

The energized sprags grip at an infinite number of positions. When torque is applied, the sprags *instantaneously* engage . . . when torque is removed, they *instantaneously* release. Positive, accurate engagement and disengagement may be made hundreds of times per minute—with no backlash.

Formsprag Full Complement Clutches always provide MAXIMUM TORQUE CAPACITY (for size and weight) . . . and LONG LIFE because of low unit stresses at changing contact points.

DISTRIBUTORS IN PRINCIPAL CITIES

Your inquiries about Balansprag and Cagedsprag Over-Running Clutches are welcomed by the Formsprag Company

for

OVER-RUNNING
INDEXING (Feeding)
BACKSTOPPING

Before you specify another clutch be sure you read this folder:

FORMSPRAG COMPANY
23607 Hoover Road, Van Dyke, Michigan

Send the folder to:

NAME_____

TITLE_____

COMPANY_____

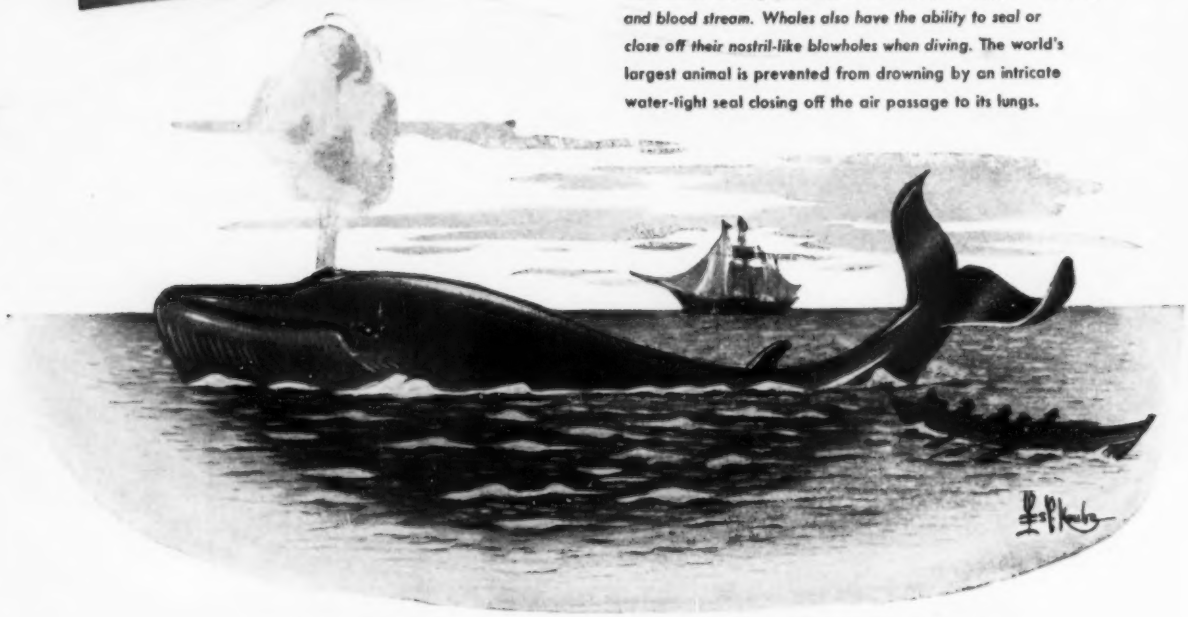
ADDRESS_____

_____

LESSONS IN HYDRAULICS

The Great Whale

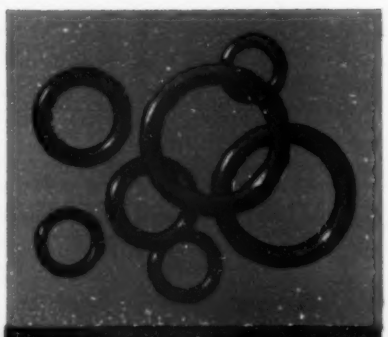
Whales are the largest animals the world has ever known—larger even than dinosaurs. Blue or Sulphur-bottom whales may reach 75 or 100 ft. in length and weigh as much as 125 tons. While they look like fish and live only in the oceans, they are warm blooded, have lungs and breathe air. They are not fish but true mammals. The whale has phenomenal ability to "hold its breath" (up to an hour) while submerged. This is possible because its heartbeat and body movements slow down under water making good use of the supply of oxygen in its lungs and blood stream. Whales also have the ability to seal or close off their nostril-like blowholes when diving. The world's largest animal is prevented from drowning by an intricate water-tight seal closing off the air passage to its lungs.



NATURE'S WATER-TIGHT VALVE

The dependability and wide application of Minnesota O-Rings prove themselves in such equipment as gas valves . . . hydraulic brakes . . . compressed air equipment . . . steam or gas engines . . . lubricators . . . refrigeration machinery . . . spraying equipment. Made from special compounds of natural or synthetic rubber to satisfy specific requirements and meet rigid quality standards, *Minnesota O-Rings are the obvious answer for better packing installations in air, gas or hydraulic systems.* For prompt analysis and quotation on your requirements, send us your blue prints or specifications.

* *Bulletin available on request.*



INJECTION MOLDED MINNESOTA O-RINGS

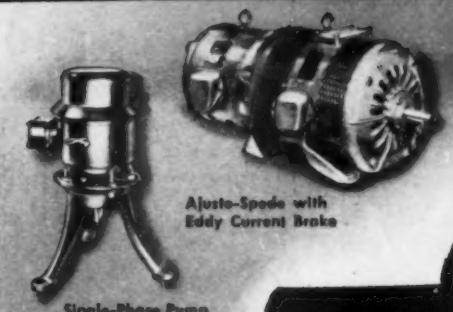
The exclusive Minnesota injection molding process makes possible mass production economies while fulfilling extreme uniformity and tolerance requirements. Special attention is paid to O-Ring tensile strength and resistance to abrasion, compression set, hydraulic fluids, heat and cold.

Manufacturers of All Types of Small Rubber Parts

MINNESOTA RUBBER & GASKET COMPANY

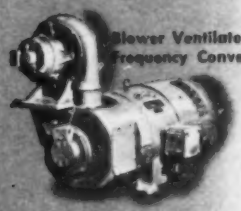
3630 WOODDALE AVE., MINNEAPOLIS 16, MINN. • Phone WHittier 6511

AFFILIATED WITH MINNESOTA SILICONE RUBBER CO. • OFFICES IN PRINCIPAL CITIES



Ajusto-Speed with Eddy Current Brake

Single-Phase Pump Motor with Tripod Base



Blower Ventilated Frequency Converter

Splash-Proof Motor with Flange

Special Arbor Type Motor

Self-Cleaning Textile Motor

Gearmotor

Rolled Shell Shaftless Motor

Oil-Well Pumping Motor

In case after case, a special motor gives more flexibility, more production, greater economy!

LOUIS ALLIS specializes in special motors!

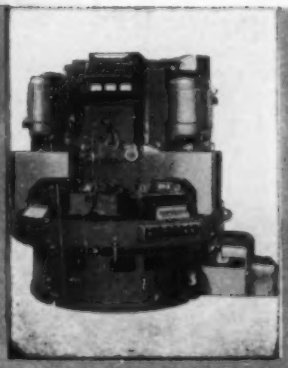
FIND out about special motors — how they help to step up machine performance. Call in a Louis Allis engineer.

He's an expert in motor design — knows control and drive characteristics. He's probably solved drive problems like yours for other Louis Allis customers. At any rate, he has a wealth of motor experience—experience that lets him make sound recommendations to you—experience that often helps you get improved product performance.

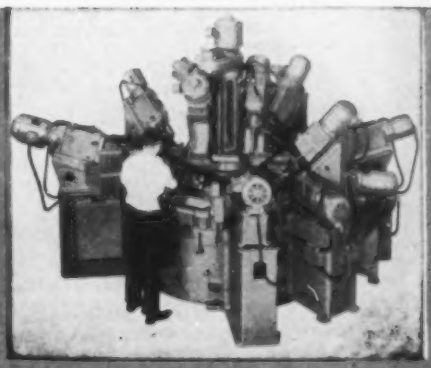
So, when you need special motors — regardless of electrical and mechanical characteristics, speeds or torque requirements — take advantage of Louis Allis' specialized know-how. Save time, save money, improve product performance. Call in the Louis Allis engineer near you.

THE LOUIS ALLIS CO., *Milwaukee 7, Wisconsin*

Two Louis Allis open, drip-proof, floor horizontal, shaftless attrition mill motors drive this double-runner attrition mill.

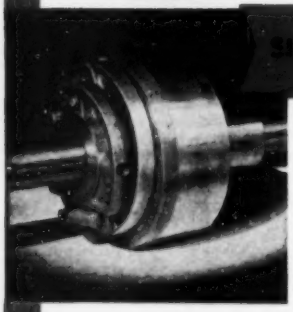


A Louis Allis frame-type, shaftless, squirrel-cage motor is built into the grinding heads of this vertical-spindle, rotary, automatic surface grinder.



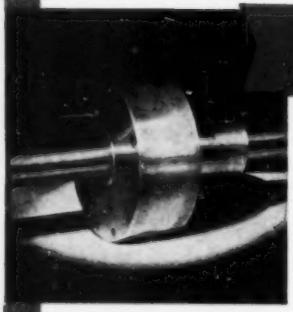
Each of the sixteen heads of this automatic drilling and tapping machine has its own Louis Allis motor designed for the specific range and type of work handled by that particular head.

HILLIARD Clutches FOR POWER CONTROL DESIGNS



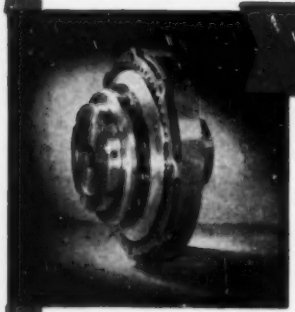
HILLIARD SINGLE REVOLUTION CLUTCH

Unequaled for accurate control of intermittent machine operations—cutting, punching and packaging. Gives closer tolerances to cut-off, stamping, shearing and similar machines. Completely automatic; manual, mechanical or electrical control.



HILLIARD OVER-RUNNING CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unsurpassed for automatic two-speed drives, dual drives, stand-by drives and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.



HILLIARD SLIP CLUTCH

A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations and many other uses.

★ HILLIARD CLUTCHES and COUPLINGS make machine drive and power transmission more efficient and economical. Experienced engineers will be glad to offer their advice on any problems. Complete descriptive material will be furnished on request.

WRITE TODAY for our illustrated brochure #MP-4 for information.

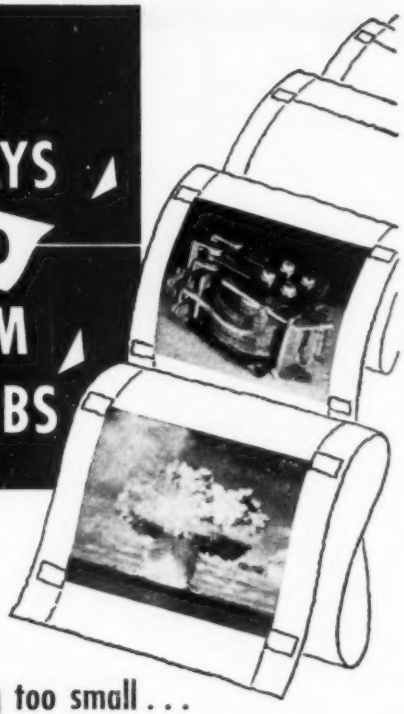
CLUTCH MAKERS FOR OVER FORTY-FIVE YEARS

THE HILLIARD Corporation

101 W. FOURTH STREET, ELMIRA, N. Y.

In Canada • • • **UPTON - BRADEEN - JAMES, LTD.**

from RELAYS to ATOM BOMBS



. . . nothing too small . . .
nothing too LARGE
for *FASTAX* . . . world's leading high-speed motion picture cameras

Our work in all fields with users of high-speed photographic equipment gives us the opportunity to see and study the operation of FASTAX cameras and equipment in the field . . . makes possible the development of finer high-speed FASTAX cameras and auxiliary equipment. That is why FASTAX has world-wide acceptance and is first choice of designers and engineers everywhere for helping solve mechanical problems.

A consultation service is available to users of high-speed photography. **WRITE.**

Wollensak
OPTICAL COMPANY, ROCHESTER, N. Y.

• RAPTAR
• RAPAX
• FASTAX

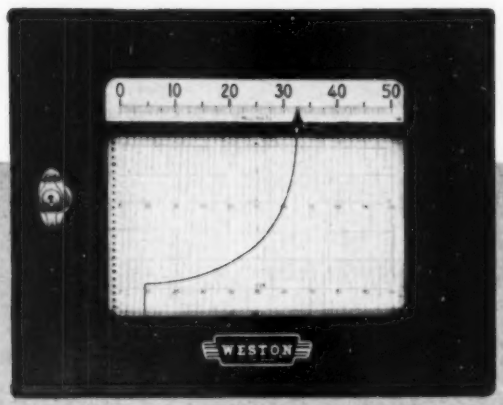
Is long trouble-free motor life a *problem?*

Bodine has a broad line of dependable motors to solve this problem for you

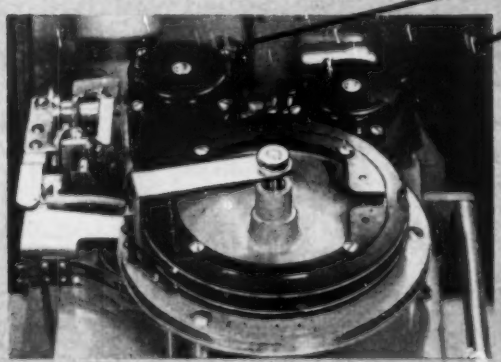
Instruments, which are the basis of the precise control of industrial processes, must be accurate and provide long, trouble-free service. The low inertia Bodine Type K motor in the Weston Recorder functions as the balancing motor and drives a contact over a slide wire. A motor operating in this capacity must be extremely sensitive to a control signal, consistent in operation and free from cogging and hunting. The other Bodine motor drives the recording chart.

The ruggedly built Bodine Type K Motor is available in sizes ranging from 1/2000 to 1/500 horsepower. Windings are distributed for highest efficiency. These motors require only a minimum of maintenance and lubrication. Where long, dependable motor life is required, specify Bodine motors.

Bodine Electric Company, 2260 W. Ohio Street, Chicago, Illinois
REPRESENTATIVES IN PRINCIPAL CITIES.
IN CANADA: RENOLD-COVENTRY, LTD.



This new Weston Recording Potentiometer can be used for a wide variety of measuring and recording applications.

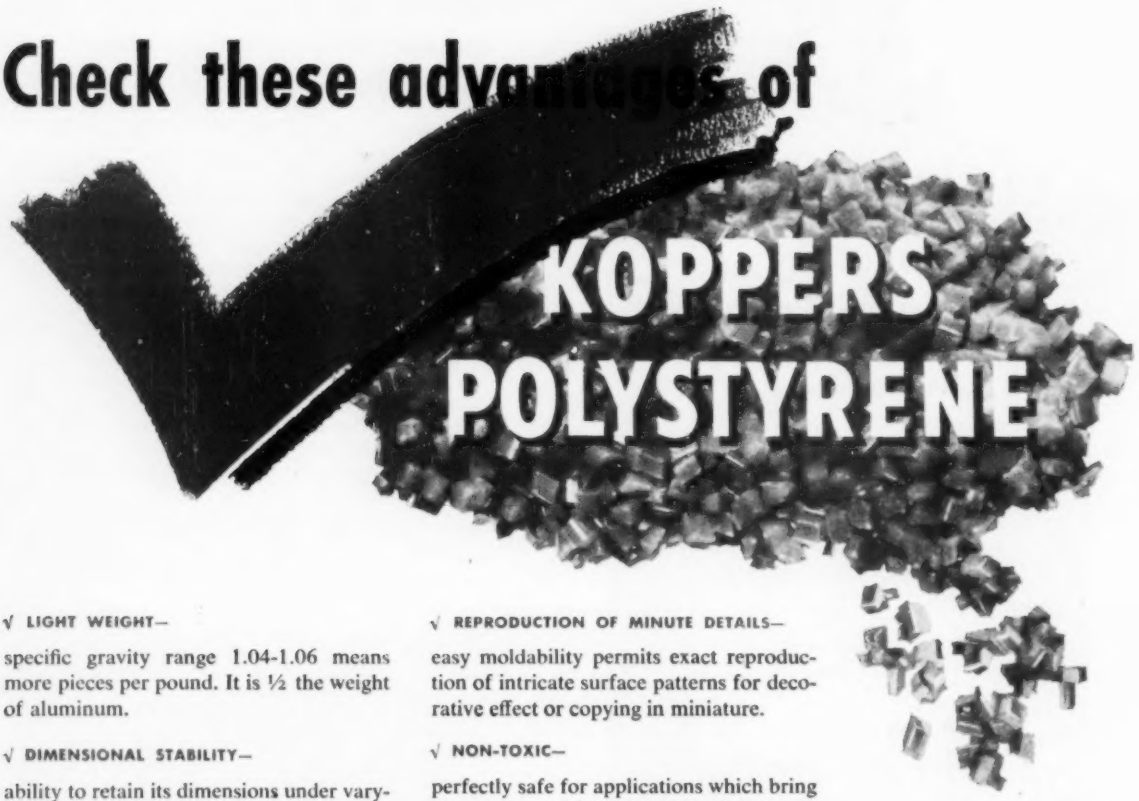


An inside view of the Weston Potentiometer showing the two Bodine fractional horsepower motors.

Bodine
FRACTIONAL HORSEPOWER
MOTORS
BODINE

THE POWER BEHIND THE LEADING PRODUCTS

Check these advantages of



√ LIGHT WEIGHT—

specific gravity range 1.04-1.06 means more pieces per pound. It is ½ the weight of aluminum.

√ DIMENSIONAL STABILITY—

ability to retain its dimensions under varying temperatures, humidity and load conditions.

√ UNLIMITED COLORS—

Koppers Polystyrenes are made in crystal-clear transparent or in any desired color. Color-matching equipment of the latest design assures accurate matching of colors.

√ CHEMICAL RESISTANCE—

resists all concentrations of most acids and alkalies.

√ ELECTRICAL PROPERTIES—

highest in dielectric strength, lowest dielectric constant, lowest power factor of all rigid thermoplastics.

√ RELIABLE UNIFORMITY—

strict control over all raw materials, plus a unique production process, enables Koppers to make polystyrene of unequalled uniformity.

√ REPRODUCTION OF MINUTE DETAILS—

easy moldability permits exact reproduction of intricate surface patterns for decorative effect or copying in miniature.

√ NON-TOXIC—

perfectly safe for applications which bring it in contact with food and liquids since it will not affect them in any manner. Hard, non-porous surface can be easily and thoroughly cleaned.

√ NON-SHATTERING—

accidental breakage does not produce dangerous slivers or sharp edges capable of cutting.

√ PLEASANT TO THE TOUCH—

smooth surfaces of Koppers Polystyrene do not irritate the skin or nerves, give a pleasant, "warm" feeling when handled.

√ LOW COST—

no other basic material has the unique combination of desirable characteristics inherent in Koppers Polystyrene at such low cost. Uniform high quality assures a minimum of rejects and additional low unit costs.

Write for further information on Koppers Polystyrenes and Modified Polystyrenes.

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	High Impact, Lowest Water Absorption Rate
MC-301	High Impact, Improved Heat Distortion Temperature
MC-305	High Impact, Easy Flow
MC-309	High Impact, Highest Heat Distortion Temperature
MC-401	Medium Impact, Improved Heat Distortion Temperature
MC-405	Medium Impact, Easy Flow
MC-409	Medium Impact, Highest Heat Distortion Temperature

Koppers Plastics Make Many Products Better and Many Better Products Possible.

KOPPERS ®

Koppers Plastics

Guaranteed by Good Housekeeping

KOPPERS COMPANY, INC., Chemical Division, Dept. PE-103, PITTSBURGH 19, PENNSYLVANIA

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · CHICAGO · DETROIT · LOS ANGELES

Try

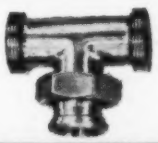
TRI-CLOVER

. . . for the best solution to your

CORROSION-RESISTANT PIPING PROBLEMS

"ZEPHYRWELD" WELDING FITTINGS—SS Type 304, 347, 316, fabricated in O.D. TUBE Sizes, ½ in. thru 36 in. Full line of ells, tees, crosses, adapters, etc.

CRITICAL END FITTINGS—SS Type 316, and other SS analyses. Complete lines of ells, tees, crosses, adapters, etc., sizes from 1 in. thru 4 in. O.D.

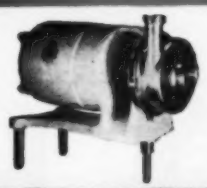


RECESSED END FITTINGS—SS Type 304, 347, 316, sizes from ½ in. thru 24 in. for butt weld or socket welding. Full line of ells, tees, crosses, etc.

STAINLESS STEEL SANITARY TYPE FITTINGS—in a complete line, 1 in. thru 4 in. O.D. Approved as meeting 3A Standards throughout. Most precision fittings are the "standard for comparison".

SPECIAL FABRICATION—Pretested fittings and assemblies to your specifications. FULL corrosion resistance assured through scientific precision welding and controlled annealing and passivating.

SCHEDULE 5-S and 10-S WELDING FITTINGS—"Zephyrweld" SS Type 304, 347, 316, full range of sizes, ½ in. thru 24 in. PIPE SIZE, for use with SS light gauge pipe.



MAGNETIC FREE-FLOW SANITARY TRAP—Fabricated from corrosion resistant type 316 austenitic stainless steel in 2", 3" and 4" O.D. sizes with home sanitary flanges (for 304 stainless tube) or I.P.S. screwed ends.

SANITARY and INDUSTRIAL PUMPS—"Headquarters" for a complete line of sanitary and industrial corrosion-resistant pumps for liquids and semi-solids.

TRI-CLOVER offers 32 years of specialized experience in solving sanitary and industrial corrosion-resistant piping problems. Skilled craftsmen and engineers in four completely equipped plants have made the name *Tri-Clover* on stainless steel and alloy fittings, valves, pumps, and specialties signify unexcelled performance.

Your selection of the *right* fitting, valve, pump, tubing or pipe for the *right* job is made easier by Tri-Clover's complete production and engineering facilities. Benefit from this fact. For here is one dependable source . . . one responsibility for your sanitary and industrial piping problems.

Our experienced engineering service is at your disposal to help solve your specific corrosion-resistant piping problems.

Remember to specify Tri-Clover.

Tri-Clover®
MACHINE CO.
Kenosha, Wisconsin

TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

THE Complete LINE

I-153

There's only ONE TAPER-LOCK

TAPER-LOCK sheaves run true! The patented Taper-Lock bushing grips the shaft for the full length of the bushing—holds with the firmness of a shrunk-on fit!

Every belt pulls its full share of the load. Grooves, machined on precision equipment, have identical pitch diameters, assuring equal belt tension.

Easy on—Easy off. Slip it on the shaft, line it up and tighten while sighting. In ease and speed of mounting and demounting you'll appreciate there is only ONE Taper-Lock.

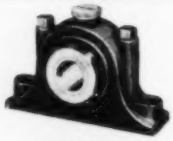
No flange, no collar, no protruding parts. Flush hub means safety.

Taper-Lock sheaves are available from distributors' stocks in complete range of sizes in A, B, C and D grooves.

DODGE MANUFACTURING CORPORATION
1200 UNION STREET, MISHAWAKA, INDIANA

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory-trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone book.



DODGE-TIMKEN PILLOW BLOCKS

TORQUE-ARM SPEED REDUCERS

ROLLING GRIP AND DIAMOND D FRICTION CLUTCHES

NAME PLATES

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1555 N. SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS.

New Hydraulic Fluid Won't Burn or Explode!

Houghton

HOUGHTO-SAFE

IS SAFE 7 WAYS!

5 years in the Lab
—now proved in the field!
CONVENTIONAL OIL BURNS INSTANTLY . . . An atomized jet of regular hydraulic oil pressure-sprayed into flame from a blow torch ignited immediately into an 8-foot blaze!
HOUGHTO-SAFE WOULDN'T IGNITE! This non-flammable fluid, similarly sprayed under pressure into the same flame, would not ignite—no flash, no flame!
HOUGHTO-SAFE
Ask the Houghton Man for our new bulletin, containing research data, case histories and pictured proof of Houghto-Safe's efficiency. Or write to E. F. Houghton & Co., Philadelphia 33, Pa., for answers to any questions you may have about this new safe hydraulic fluid.

Perfected after more than five years of research and field testing, Houghto-Safe offers protection to both men and machines. This new hydraulic fluid . . . rated "acceptable from the fire hazard standpoint" by Factory Mutual . . . now proves that fire-resistant qualities *can be obtained without loss in operating efficiency!* In plants performing die casting, welding, hot press forging and other hydraulic operations — especially near open flames or extreme heat — Houghto-Safe is the long-awaited answer. Here are 7 good reasons why it's really safe . . .

1. **It's Non-Flammable**—This newly-developed hydraulic fluid won't burn or flash—even when sprayed into an open flame.
2. **Prevents Corrosion**—The new formula contains inhibitors developed by Houghton to prevent corrosion and rust in any hydraulic system.
3. **It is Non-Toxic**—Safe for workers to handle—and it bears no unpleasant odor.
4. **Fortified Lubricity Saves Equipment**—Reinforced for high film strength by a chemical additive that gives metal parts greater protection for longer periods.
5. **Oxidation Stability Adds Extra Life**—Its exceptional resistance to oxidation assures longer service life—proved by over 5500 hours of testing in equipment in actual use.
6. **High Viscosity Index Reduces Wear**—New Houghto-Safe has a viscosity index of 150, showing its stability through widely fluctuating temperatures, and providing safe operation at all normal temperatures. It won't freeze—pumps easily at zero without preheating.
7. **Safe for Packings**—Has no ill effect on synthetic rubber packings—neither attacks them nor impairs their high efficiency throughout their effective life.

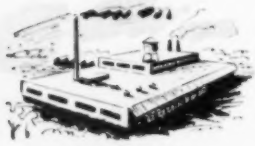
HOUGHTO-SAFE . . . a product of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

AVIATION

MARINE



INDUSTRIAL

BROADCASTING

RADIO-TV LEAD-INS

TEST EQUIPMENT

RADAR, PULSE, EXPERIMENTAL EQUIPMENT AND SPECIAL TYPES

TRUSTWORTHY TRANSMISSION

For Every HF · VHF · UHF Application

With Federal's *QUALITY-CONTROLLED* COAXIAL CABLES

Whatever your field of application . . . whatever your transmission line requirement . . . Federal is ready to serve you. If the cable you need doesn't exist, Federal will cooperate with you in developing and producing it in any quantity!

Federal offers you one of the nation's most diverse stocks of RG type cables—including the Federal-developed low-temperature, non-contaminating thermoplastic jacket.

Quality-controlled throughout the entire manufacturing process, Federal cables bring *trustworthy transmission* to every electronic application . . . *plus* top flexibility and superior resistance to abrasion, weathering and corrosion.

Before you specify cable—or complete cable assemblies—for any general or military application, get the facts and figures from Federal. *We have the answer or we can get it!*

FEDERAL HAS A NEW CABLE CATALOGUE

This new 28-page buying guide contains a world of up-to-date information on Federal's quality-controlled cables, plus numerous useful tables and diagrams. For your free copy, write to Federal today, Dept. D-742.

Manufacturer of America's most complete line of solid dielectric cables

FEDERAL TELEPHONE & RADIO — FTR — DIVISION OF IT&T

Federal Telephone and Radio Company

SELENIUM-INTELIN DEPARTMENT • 100 KINGSLAND ROAD, CLIFTON, N. J.

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

for those 'round the Clock jobs!

NEW 150 SERIES
½ to 1½ h. p.

This new series of drives runs at low input speeds, 1200 RPM and 1800 RPM, giving still greater durability and quietness of operation.

GET Graham

the variable speed drive you can Depend on!

COMPACTNESS. Only the Graham is built as a straight-line extension of a standard induction motor (or available without motor) — the ultimate in simplicity and compactness.

UNLIMITED SPEED RANGE. Only the Graham gives unlimited speed range from any desired maximum speed to zero, plus reverse if wanted, without stopping the motor.

BUILT-IN GEARBOXES. The Graham may be had with built-in reduction or step-up gearboxes — single reduction or double reduction spur or single reduction worm, thus saving the cost and complication of separate gear units.

UNMATCHED FOR ACCURACY. The Graham is unmatched for accuracy of speed setting and resetting and speed holding. The Graham may be held at the same setting for *continuous* operation — 24 hours a day for months or years, without alteration in speed, or its speed may be changed continuously on jobs requiring cyclic speed change. On the tough jobs requiring the ultimate in accuracy the Graham gets the bid.

NO PERISHABLE PARTS. The Graham has no perishable parts such as belts or tubes requiring periodic replacement. It is an all-metal, self-lubricated unit, built like the highest type speed reducer.

A PERFORMANCE RECORD. The Graham has a performance record of over fifteen years' satisfactory use as standard equipment by leading makers of machines (OEM buyers) such as conveyors, feeders, white printers, pumps, welding positioners, machine tool feeds, testing machines, integrators, printing machines, etc., etc.

GET Graham
most reliable variable speed drive made

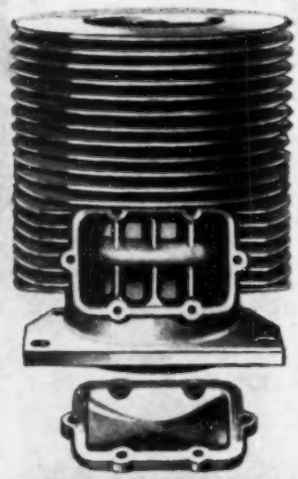
Because engineered and rated for continuous 'round the clock service

Mail This Coupon NOW...

GRAHAM TRANSMISSIONS, INC.
DEPT. PE, MENOMONEE FALLS, WISCONSIN
Gentlemen: Please send your latest catalog on *Graham Variable Speed Drives.*

Company .....
Name ..... Title .....
Address .....
City ..... Zone ..... State .....

Lightweight, Strong PARKER Die Castings Reduce Costs on POULAN CHAIN SAW!

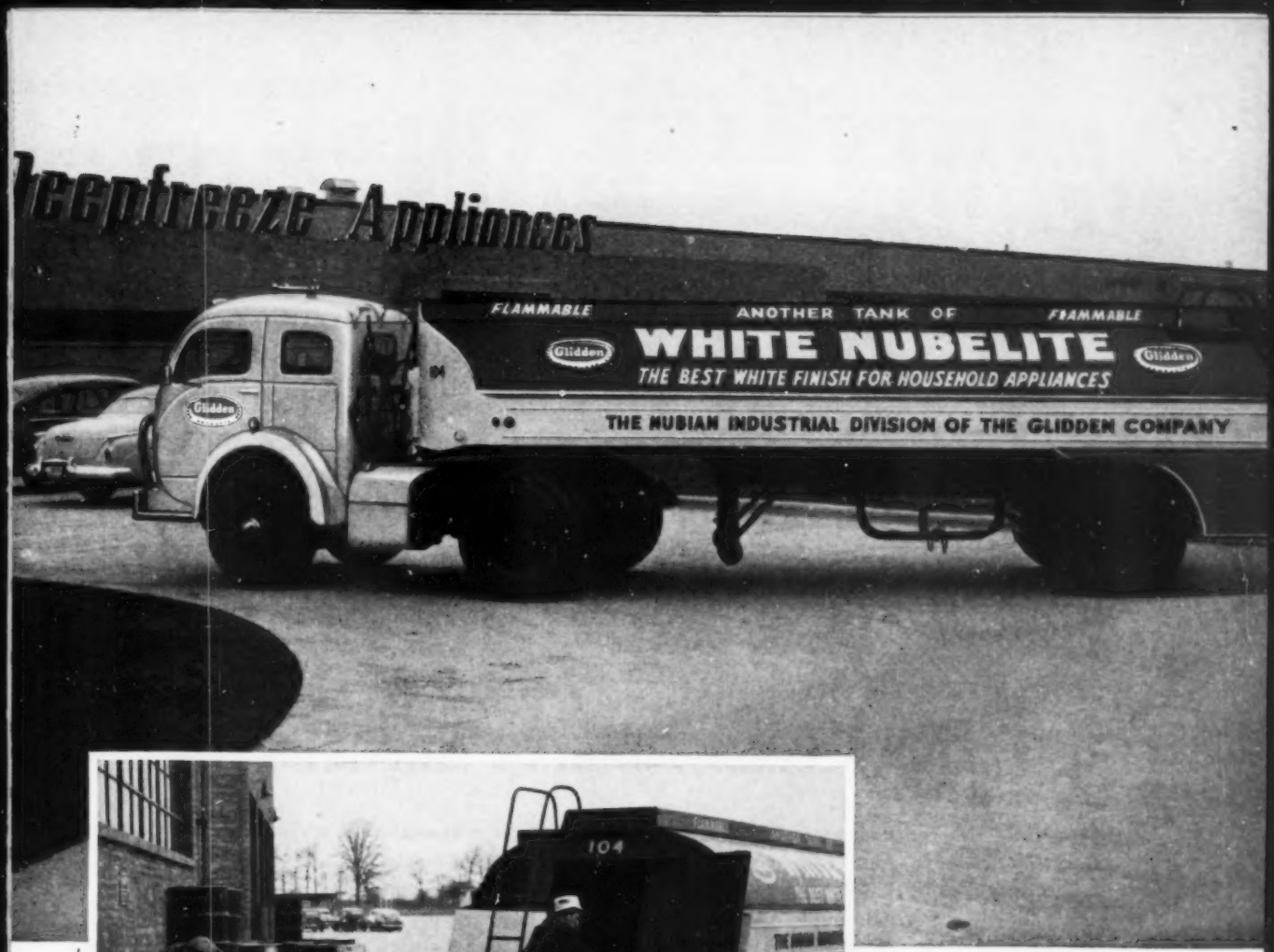


THE versatile, rugged Poulan Chain Saw is a boon to woodsmen everywhere. Its portability and ease of handling have made it a profitable piece of equipment to those engaged in the lumbering industry. Lightweight, strong die castings by Parker serve to lighten the load of the operator. The die cast engine cylinder and cover have helped reduce production costs since machining of the die cast part is eliminated. The die cast fins on the cylinder wall are strong and clean, diffusing heat evenly. This is another of the hundreds of instances where Parker Die Castings have lowered costs for manufacturers in nearly every industry. Parker Die Castings are lightweight, strong and clean. Machining is virtually eliminated. Consult with Parker on your next die casting requirements.

and when you think of Die Castings THINK OF

Parker White-Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER ALUMINUM *and* ZINC *Die Castings*



4000-GALLON PAINT CAN—ON WHEELS!

Newest thing on the highways is this 4000-gallon tank truck, one of a fleet used by The Glidden Company to deliver industrial finishes to customers' bulk storage facilities.

Finishes are filtered directly from Glidden mixing room into the trailer . . . strained from the trailer into customers' tanks. Delivery is faster . . . customers' handling costs are substantially reduced, contamination is minimized, material losses are eliminated. This is another example of Glidden Customer Service.

THE GLIDDEN COMPANY

INDUSTRIAL FINISHES DIVISION

11005 Madison Avenue • Cleveland 2, Ohio

SALES OFFICES AND FACTORIES: San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Avenue), Minneapolis, New Orleans, St. Louis, Cleveland, Reading, Atlanta and Toronto

PARTS LIKE THESE

are produced better . . . at lower cost *by* ALLIED'S COLD FORGING METHODS

Shown at the right in actual size is one of the many cold forged parts being produced by Allied.

By no other method could this particular part, or any of the other parts illustrated above, be manufactured as economically as by cold forging. However, to produce such parts requires ingenious engineering and production methods . . . and it is at Allied where you will find the best examples of cold forging ingenuity at work.

If you have need for parts similar to these . . . if you require tolerances as close as may be required for most machined parts . . . if you want maximum strength and durability in the parts produced . . . it will pay you to investigate what Allied can do for you. Send your part prints for quotation.

Other Allied Products

HARDENED AND PRECISION GROUND PARTS SHEET METAL DIES PRODUCED IN IRON, ALLITE (ZINC ALLOY) AND PLASTIC • R-B INTERCHANGEABLE PUNCHES AND DIES

STANDARD HEXAGON HEAD CAP SCREWS

Also produced by Allied are standard hexagon head cap screws. They are of uniformly high quality and are priced competitively. Your inquiry will receive prompt attention.

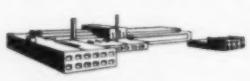
PRECISION • EXPERIENCE • DEPENDABILITY

ALLIED PRODUCTS CORPORATION

ALLIED PRODUCTS CORPORATION

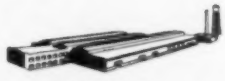
DEPT. D-14 • 12639 BURT ROAD • DETROIT 23, MICH.

PLANT 1
Detroit, Mich.



PLANT 2
Detroit, Mich.

PLANT 3
Hillsdale, Mich.



PLANT 4
Hillsdale, Mich.

Not A Flight of Fancy

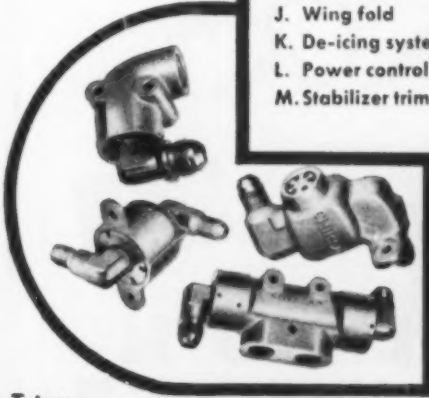
HERE ARE WAYS CHIKSAN CAN HELP AIRFRAME MANUFACTURERS

The airplane shown here is not an actual picture of any one plane. Rather, it is a composite to show some of the varied ways in which Chiksan planning can help the airframe manufacturer do a better job.

Fuel, oil, water, air and oxygen all find dependable, safe, uninterrupted flow through Chiksan aero-hydraulic swivel joints and assemblies.

CHECK THESE APPLICATIONS IN YOUR BLUEPRINTS:

- A. Refueling boom assembly
- B. Steering control mechanism
- C. Brake system
- D. Spoiler actuating mechanism
- E. Fuel and oil lines
- F. Adjustable sweep-back system
- G. Emergency dump chute
- H. Flap actuating system
- I. Power-plant fuel and oil lines
- J. Wing fold
- K. De-icing system
- L. Power control system
- M. Stabilizer trim



A few of the many Chiksan aero-hydraulic swivel joints made for pressures ranging from 1000 to 3000 psi.

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

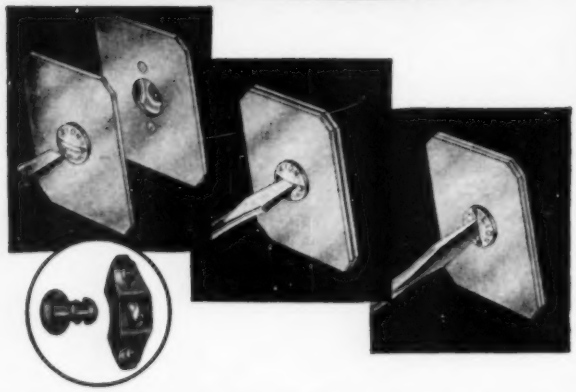
REPRESENTATIVES IN PRINCIPAL CITIES

CHIKSAN
TRADE MARK

For Parts that must be

TAKEN OFF–PUT BACK–BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN

Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

TYPICAL APPLICATIONS: INSPECTION PLATES • COWLING • ELECTRICAL PANELS • CABINETS • DUCTWORK

Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

LION FASTENERS, INC.

300 Main St., Honeoye Falls, N.Y.

IN CANADA A.T.R. ARMSTRONG CO., 50 ST. CLAIR AVE., WEST, TORONTO

Wear Defying

SILVER KING

INDUSTRIAL COUNTERS

Silver Kings challenge comparison! On casual examination, critical analysis, or the most exhaustive life tests they come out miles ahead.

Built rugged as an army tank, they operate smooth as a watch. Extra heavy shaft, oversize bearings, life-tested parts, light weight number wheels, tamper-proof reset, all-steel housings, chrome-plated finish—you can install Silver Kings with assurance of maximum dependability, longest life, lowest upkeep cost.

Available in Stroke and Revolution types, 5- or 7-digits, right or left shaft, knob or key reset.

Ask your PIC Representative to show you a Silver King or write us.

PRODUCTION INSTRUMENT COMPANY

702-10, W. Jackson Blvd., Chicago 6, Ill.

Herbrand

PRECISION

DROP FORGINGS

. . . any size or shape up to 200 lbs.

Whatever your requirements in forgings, Herbrand is your most faithful source of supply as it has been for hundreds of industries since 1881.

Your inquiries are solicited.

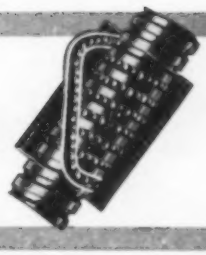
Herbrand DIVISION

THE BINGHAM-HERBRAND CORPORATION

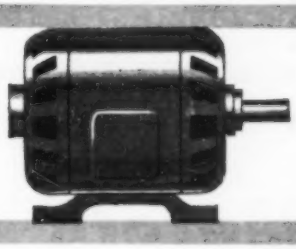
FREMONT, OHIO

To MOVE with less EFFORT

BALL-SCREW ACTUATORS



REDUCE THIS



TO THIS

If you could take about 80% of the friction out of your moving device, you could vastly reduce the size of motor needed.

Our ball-screw actuator is a combination of the screw (for power) and balls (for friction-free movement).

Many U. S. airplanes have installations of our ball-screw actuators. They have been used to help replace big motors with small ones; to improve control of motion; to eliminate human work required to crank something.

Besides saving weight and reducing the cost of friction—besides providing absolutely smooth motion—besides minimizing need for lubrication—the Ball-Screw Actuator permits the precision control of metal to metal. You can stop on a split micron!

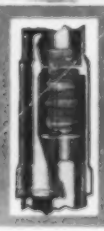
We have expanded our capacity so that we can engineer industrial applications now. Write for booklet describing actuators and their uses.

CLEVELAND PNEUMATIC
TOOL COMPANY
DEPT. KE-10 • CLEVELAND 5, OHIO

BALL-SCREW ACTUATORS AIR-OIL SHOCK ABSORBERS
AUTOMOTIVE SHOP EQUIPMENT

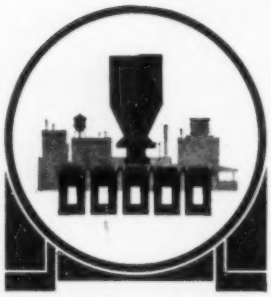
To CUSHION SHOCK...

CPT's shock absorber principle combines pneumatic and hydraulic cushioning. It can control minute vibrations or tons of impact. It is the shock absorber for the largest aircraft landing gear (CPT is world's biggest manufacturer of landing gears), but the principle can be adapted to finger-sized units. May we discuss with you how to use the shock out of stopping or take the motion out of vibration?



WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

Metal Working



Food Processing

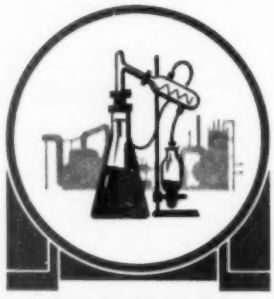
Grain Handling

Electric Motors

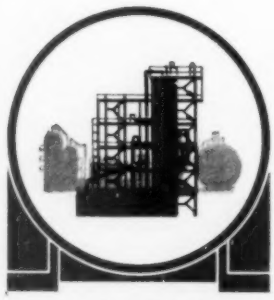
for every industry

When you need electric motors . . . in any rating, or frame type . . . one or a thousand . . . *always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry.

Fairbanks, Morse & Co., Chicago 5, Illinois.



Chemical Processing



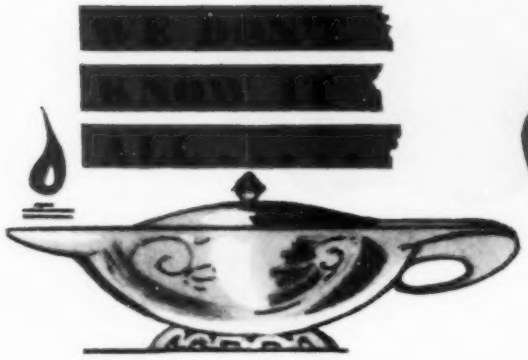
Petroleum Refining

Fairbanks-Morse totally-enclosed, fan cooled motor—in a complete horsepower range.

FAIRBANKS-MORSE

a name worth remembering when you want the best

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS



16" long, 8½" de, 6" deep

. . . . . BUT WE DO KNOW HOW!

There are "knacks" in the production of deep drawn stampings . . . things learned only by experience . . . never found in books. That is one reason why you should consult with a T&W Stamping Specialist . . . perhaps he will save you money by the "knacks" he has learned. Many of the leading users of deep drawn stampings have benefited from this association with Transue's . . . . . .

Transue & Williams

Sales Offices: NEW YORK, DETROIT, CHICAGO, CLEVELAND, PHILADELPHIA, INDIANAPOLIS

FIBER PPG GLASS

Bigger muscles for paper

Helps make products better, safer, lighter, stronger

Paper has been getting stronger and stronger, taking on tasks in recent years that were once undreamed of. One of the biggest boosts in strength has come from fiber glass reinforcements. Today, paper reinforced with fiber glass is used for such heavy-duty jobs as wrappings for steel and other industrial packaging, freight car shrouding and temporary tarpaulins, bags for chemicals and other bulk materials, manufacturer's joint for corrugated cartons, concrete curing and many other types of reinforced paper and tapes.

Pittsburgh Fiber Glass confers great tensile strength with the least weight of any type of reinforcement. Papers thus reinforced are relatively light in weight and pliable, resist moisture and severe weathering and handling. For information or assistance with paper reinforcements, or with any other application involving fiber glass, contact any of our offices. Pittsburgh Plate Glass Company, Fiber Glass Division, 420 Fort Duquesne Boulevard, Pittsburgh 22, Pa. District Offices: Chicago, Cincinnati, Cleveland, Detroit, New York, Washington.

FIBER PPG GLASS PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

space-ship shapes

Up to now we haven't made any shapes for a rocket ship to the moon. However, we'll wager a Saturn ring against an asteroid that some design engineer, somewhere, has a few out-of-this-world transportation ideas that will someday need the kind of metal shapes we can and do produce.

In the meantime, designers of things that move by wing, wheel or water will continue to benefit by exploiting the economic and functional possibilities of Van Huffel metal shapes and tubing.

APPLIANCES

BUILDING CONSTRUCTION

METAL FURNITURE

FARM EQUIPMENT

COMMUNICATIONS

Van Huffel

TUBE CORPORATION · WARREN, OHIO

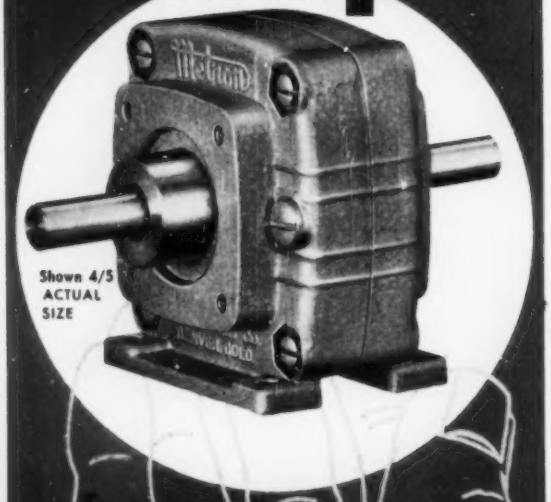
where ideas take shape *for the industries that serve the nation*

NEW!

THE Metron

BANTAM

SPEED CHANGER



SAVE SPACE
READILY AVAILABLE
SEALED OIL-BATH LUBRICATION
OPERATE IN ANY POSITION
COMPACT, RUGGED OPERATION
LOW POWER LOSS

Metron INSTRUMENT COMPANY
444 Lincoln Street • Denver, Colo.

STRENGTH WITHOUT BULK

The exceptional tensile and torsional strength of Mac-it Screws makes it possible to use smaller, lower cost screws for all fastening jobs. Mac-it Special Alloy Steel used in all Mac-it Screws is held to rigid specifications, assuring uniform and dependable screw fasteners.

PRECISION FASTENERS

The precision manufacture and quality control used in making Mac-it Screws provide users with high dimensional accuracy and uniformity. All Mac-it Screws in both coarse and fine threads are held to a class-3 fit.

MAC-IT SCREW ENGINEERING

Mac-it maintains a fastener engineering service for the design, development and production of screws to suit all types of applications.

SPECIFY **Mac-it** ® FOR ALL THESE ADVANTAGES

ONE MAC-IT CALL GETS 'EM ALL!

SPECIAL SCREW PRODUCTS

Mac-it is geared for either large or small run production of screws with special design or strength characteristics.

HEAT-TREATING

Mac-it heat-treatment is more than a mere case hardening or surface processing. The high quality of Mac-it Special Alloy Steel adapts it to heat-treatment that penetrates throughout the structure of the screw so that the center possesses the same sturdy toughness possessed by the outside. Proved formulas govern this process.

Each type Mac-it Screw is heat-treated to possess maximum strength for the particular purpose for which it is to be used. No one heat-treatment is best for all purposes.

DISTRIBUTOR SERVICE

Contact any of the hundreds of Mac-it distributors from coast to coast for immediate service to supply your requirements for standard or special screws.

MAC-IT SCREW DEPARTMENT
STRONG, CARLISLE & HAMMOND COMPANY
1392 W. 3RD. STREET • CLEVELAND 13, OHIO
Manufactured by Mac-it Parts Co., Lancaster, Pa.

Electronic spacer patterns guide stockpile through sequence of cuts automatically. Responsive Oilgear Transmission provides speedy travel with pin-point stopping within 3/1000ths of an inch from zero tolerance. Lawson Cutter also used in repetitive single cuts and for trim on sides. Photo in plant of Liedtke Brothers, Chicago.

The RESULT?

Accuracy just 900% better

Production increase 50 to 500%

Over and over and over again, Oilgear Fluid Power proves to be the right solution to a drive problem. Take the case of the Lawson Cutter.

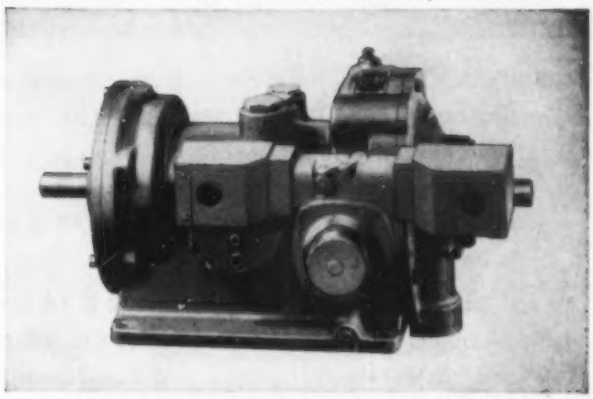
If precision is emphasized anywhere, that "where" is the field of fine color printing of every description. Money, time, effort are spent that art be right, that plates be right, that printing be right—to a hairline. And then comes the cutting operation where all that has gone before is saved—or wasted. Small wonder that cutting remained a hand operation for many years.

But the E. P. Lawson Company, manufacturer of cutting machines, wanted to modernize and mechanize the operation. Its designers turned to an electronic spacer device. This if anything would give precision in marking *where* to cut. But the next problem was to find a power drive capable of *obeying* the orders the electronic signal system was capable of *giving*. Lawson tried one type of drive. It varied all over the map. Lawson tried another type of drive. It was fairly accurate —but did not hold up.

Finally, as so many machine designers have done, Lawson turned to Oilgear. And there, as so many machine designers have done, Lawson found the answer to its problem.

The answer? Undeviating accuracy within 3/1000ths of an inch from zero tolerance—just 900% better than what had been achieved in the past; speed, translating into production increases of 50% to 500% month in and month out. How? Through the absolute responsiveness of Oilgear Fluid Power Drive to the automatic control system. Immediate, shockless acceleration to full speed "forward". Precise measured slowdown as the feed fence nears the target. Precision stopping "on target" for the cut and then rapid acceleration toward the next cut.

Here again is an example of the superlative "right-



Oilgear Two way Variable Speed Transmission as used on Lawson Electronic Spacer Cutters. These drives also provide unlimited speed range from zero to maximum. Speed changes made in split second or specified time.

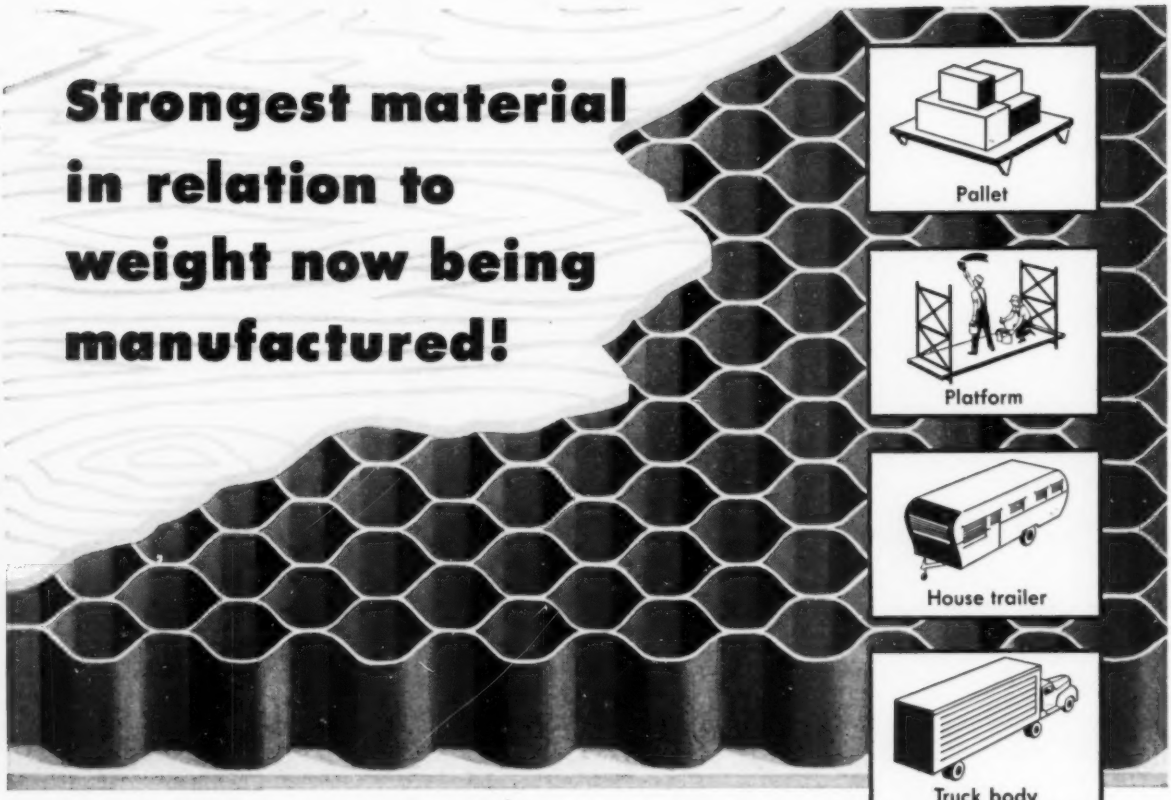
ness" of Oilgear Fluid Power "generators," motors, transmissions—for almost any type of installation or machine requirement, big, little, and all those in between.

Chances are Oilgear is *the* solution you've been looking for. And Oilgear engineers will be just as quick to tell you if Oilgear is *not* for you. Ask for further information from an Oilgear Engineering Representative. No charge. No obligation. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

OILGEAR

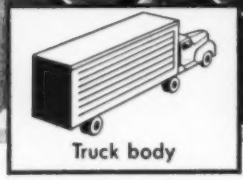
Strongest material in relation to weight now being manufactured!

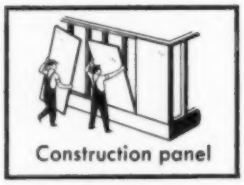


Pallet

Platform

House trailer


Truck body


Construction panel

Air-Cargo container

Drafting board

- It's AIRCOMB... an exciting development of the Douglas Aircraft Company. AIRCOMB is a honeycomb structure of Kraft paper impregnated with a phenolic resin. In use it is sandwiched between faces of thin material such as aluminum, wood, plywood, stainless steel or magnesium. It is shipped pre-cut in any thickness from 1/16" to 5".

  In panels, this high-strength material is *16 times* as rigid as an equal weight of steel! It is durable, fire-resistant, pest-resistant and has excellent insulation and soundproofing properties.

  Illustrated at right are some present and potential uses of AIRCOMB. Engineering advice on how to adapt this superior structural material to your needs is available.

- The use of AIRCOMB instead of heavier materials allows large savings in the cost of manufacturing and shipping your product. For information write to AIRCOMB Section, Douglas Aircraft Company, Inc., Dept. L-32, 3000 Ocean Park Boulevard, Santa Monica, California.

AIRCOMB

TRADE MARK

DOUGLAS

A PRODUCT OF DOUGLAS AIRCRAFT COMPANY, INC.

Manufacturing rights in foreign countries are available

We specialize in solving problems of MOTION

top 10 SOURCES for Mechanical Springs

Contact any Division for Action

WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT

THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE. CHICAGO 14.

RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVAMIA

BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD. PLYMOUTH, MICH.

B-G-R COOK PLANT
ANN ARBOR MICHIGAN

F. N. MANROSS AND SONS CO.
BRISTOL CONNECTICUT

OHIO DIVISION
1912 EAST FIRST ST. DAYTON, OHIO

DUNBAR BROTHERS COMPANY
BRISTOL, CONN.

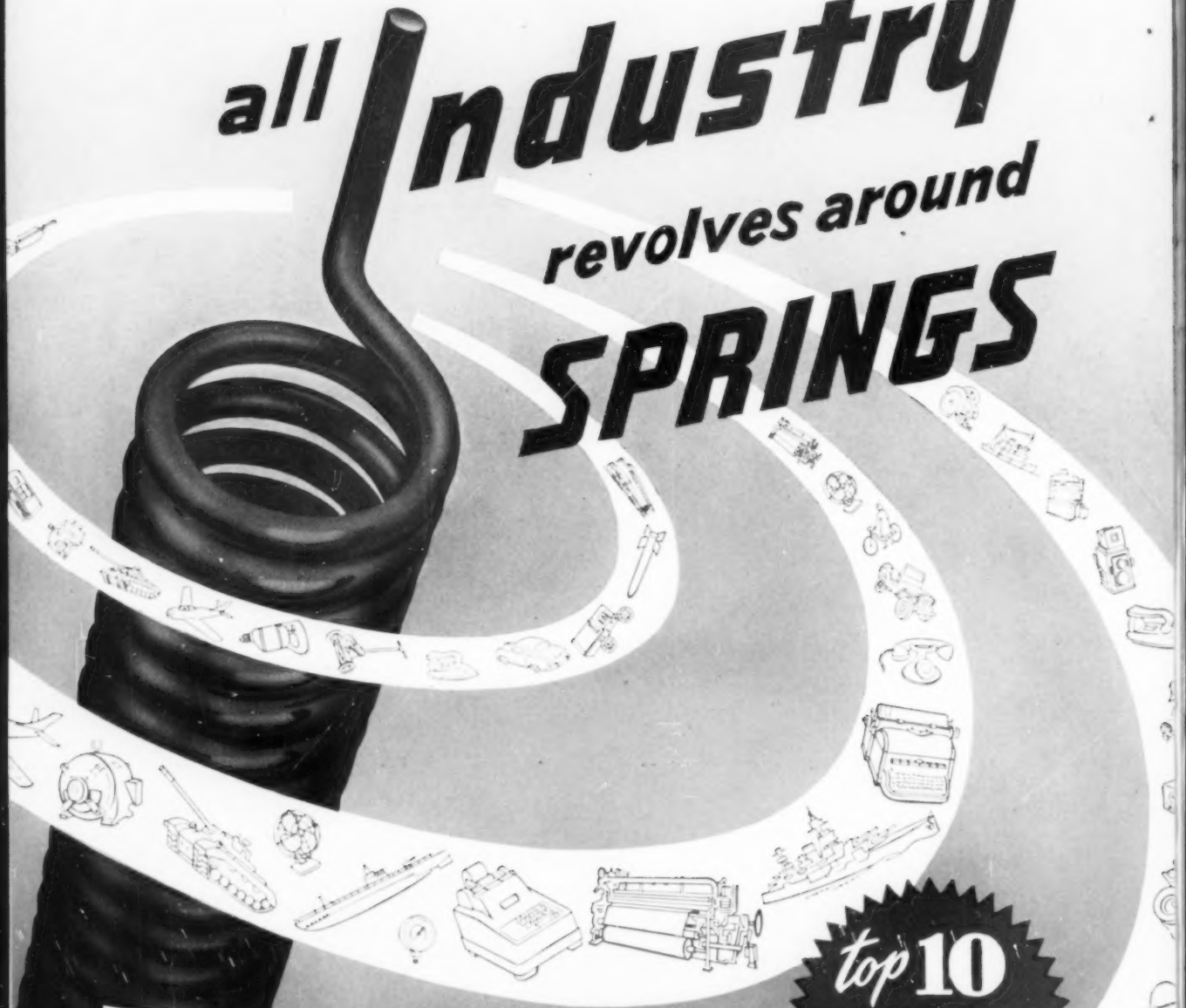
MILWAUKEE DIVISION
341 E. ERIE ST. MILWAUKEE, WIS.

SEABOARD Coil Spring Div.
435 E. WASHINGTON BLVD. LOS ANGELES 15.

IN CANADA - The WALLACE BARNES CO., Ltd., Hamilton, Ontario

DIVISIONS OF ASSOCIATED SPRING CORPORATION

all Industry revolves around SPRINGS



All Industry turns to the

top 10 SOURCES for Mechanical Springs

WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT

THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE.
CHICAGO 14,

RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA

BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD.
PLYMOUTH, MICH.

B·G·R COOK PLANT
ANN ARBOR
MICHIGAN

F. N. MANROSS AND SONS CO.
BRISTOL
CONNECTICUT

OHIO DIVISION
1712 EAST FIRST ST.
DAYTON, OHIO

DUNBAR BROTHERS COMPANY
BRISTOL, CONN.

MILWAUKEE DIVISION
341 E. ERIE ST.
MILWAUKEE, WIS.

SEABOARD Coil Spring Div.
435 E. WASHINGTON BLVD.
LOS ANGELES 15,

DIVISIONS OF
ASSOCIATED SPRING CORPORATION

IN CANADA - The WALLACE BARNES CO., Ltd., Ha

How would YOU solve these two problems?

1. STORING BULKY FILES. Engineers examine one of 90 compact microfilm rolls that reduce 70,000 drawings, each about 6 square feet in area, for space-saving storage. In a process developed by the Diebold Manufacturing Co. for continuous developing of microfilm, rigid temperature control is essential in the "fixing" tank. Fenwal THERMOSWITCH® unit keeps the "fixing" solution constantly within one degree of the required 100°F.

Photo courtesy of Hotel Statler, Boston

2. KEEPING DISHES SPOTLESS. For this full-time restaurant job, the Statler Hotels and other leading firms serving the public use Colt Autosan Dishwashing Machines. Fenwal THERMOSWITCH devices in these machines have two functions. The first is to control temperature of washing water. Other units act as low-temperature cut-off switches — stopping the conveyor belt if water becomes too cold.

3. A FENWAL THERMOSWITCH CONTROL may solve your problems, too. Its external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of otherwise costly problems.

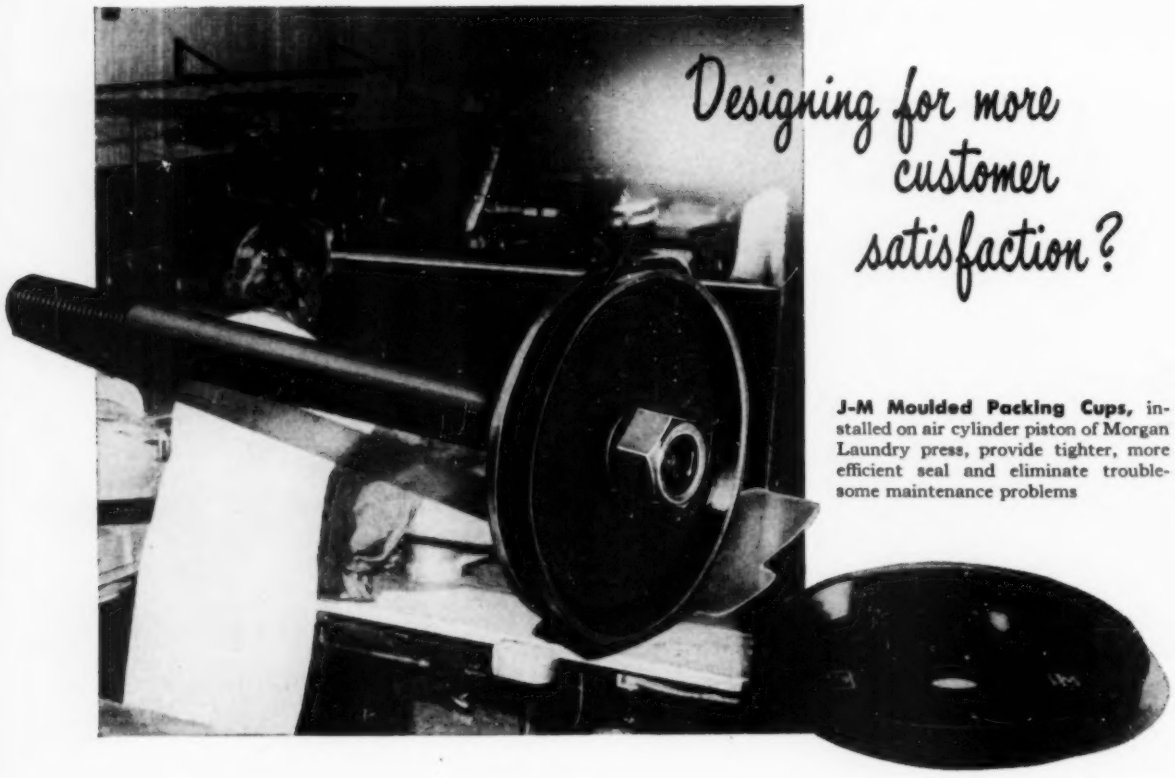
4. SEND FOR THIS CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. **Write Fenwal Incorporated, 210 Pleasant Street, Ashland, Massachusetts.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE...*but only to heat*



Designing for more customer satisfaction?

J-M Moulded Packing Cups, installed on air cylinder piston of Morgan Laundry press, provide tighter, more efficient seal and eliminate troublesome maintenance problems

When Morgan Laundry changed to J-M Moulded Packing Cups, they found

"Maintenance on packings practically eliminated . . ."

The Morgan Laundry, large supplier to hotels and institutions, encountered excessive down time for maintenance of their laundry presses. Packings supplied as original equipment on the air cylinder pistons of the presses needed frequent lubrication to prevent drying out. It was difficult to maintain proper cleanliness of the equipment.

When the company replaced the conventional material with J-M Moulded Packing Cups, packing life was increased. These packings required practically no maintenance, and the danger of soiling laundry because of relubricating packings was completely eliminated.

Designers and manufacturers can offer their customers many advantages by providing J-M Moulded Packing Cups on original equipment. These custom-made materials may be used on practically all types of air- or hydraulic-operated cylinders. They help improve operating efficiency, and they make possible easier, cleaner maintenance. These factors are especially important in critical installations such as hospitals and hotels, as well as laundries and other service establishments.

J-M Moulded Packing Cups are available in a variety of compositions to meet a wide range of pressures, temperatures and service conditions. For more information on all types of Johns-Manville Moulded Packing Cups, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

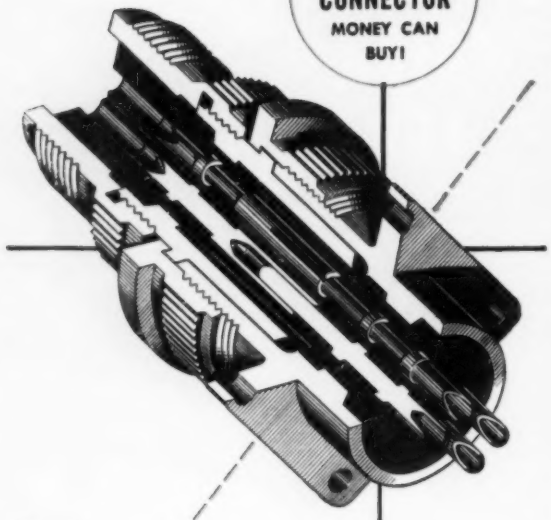
Johns-Manville PACKINGS & GASKETS

This specialized EEMCO motor design employs an in line double spur gear reduction for heavier operating loads or applications where shock loads are experienced, such as air compressors. It is rated at 2½ h.p. for continuous duty, 27 volts D.C. Output speed is 3650 RPM. Unit includes radio noise filter and standard AND 20001 mounting pad and drive.

ELECTRICAL ENGINEERING & MFG. CORP.
4612 West Jefferson Blvd.
Los Angeles 16, California

3-519

The Finest
ELECTRICAL
CONNECTOR
MONEY CAN
BUY!



SCINFLEX ASSURES
YOU PEAK PROTECTION
AGAINST CIRCUIT FAILURE

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

BENDIX SCINFLEX
ELECTRICAL CONNECTORS

Bendix
SCINTILLA MAGNETO DIVISION of Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.
FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California.

ALWAYS IN
HIGH GEAR

For the production of precision built gears to meet your specifications. Diefendorf meets the demands of industry for gears of all sizes, metal and non-metallic, for specially designed equipment or for contract manufacture.

DIEFENDORF
GEAR
CORP.
Syracuse, New York

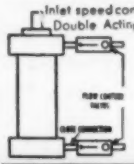
DIEFENDORF
GEARS

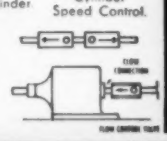
Get Easier, More Accurate Cylinder Speed Control
with
Pneu-Trol
VALVES
IN AIR OR
HYDRAULIC USE

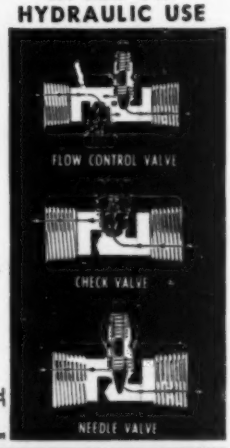
2000 and
5000 (steel) P.S.I.

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 6 female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

Write for Illustrated Circular and Price List.







Pneu-Trol Devices, Inc.
1428 N. Keating Ave., Chicago 51, Ill.

You can pour molten metal at 1800° F. into a VYCOR brand glass dish resting on a cake of ice without fear of breakage. No other commercial glass can match such resistance to thermal shock.

Now–

cooking with light

heat-resistant glass makes possible new conception in range manufacture

The red-tinted cover plate of the new range lamp, manufactured by Sylvania Electric Products Inc. for Sears Roebuck & Company Kenmore ranges, is made of a high-heat-resistant VYCOR brand 96% silica glass. Envelope of the lamp is another VYCOR brand glass.

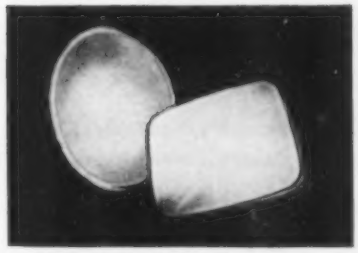
Flick a switch and this 1550-watt lamp melts a pat of butter in the time it takes a conventional coil unit to soften the edges. That means immediate and evenly distributed heat – and a glass surface that's easy to keep clean.

There were several problems in designing such a lamp: First, was there a glass that could stand the lamp's intense heat? Second, how could the lamp's brilliant light be shielded?

Corning solved these problems with two different high temperature resistant VYCOR brand glasses: a clear glass for the lamp bulb; a tinted glass for the cover plate which protects the bulb and cuts the light to a pleasant red glow when the switch is on.

Extreme heat-resistance and infrared transmission are only two of the many properties you can get with Glass by Corning. Photosensitive glass, electrically conductive glass, hermetic glass-to-glass or glass-to-metal seals, high transparency, to mention a few, have found valuable applications in the appliance field. Perhaps you have a product design problem which can be solved with versatile GLASS. We'll be delighted to explore it with you.

Meanwhile, you'll find much of interest in the booklet, *"Glass–its increasing importance in product design."* Mail the coupon today for a free copy.



PYREX brand glass No. 7740, combines easy cleaning with heat resistance to add sales appeal to any appliance. Shown here are PYREX brand oven, washer and dryer windows.

The April-May issue of the "Corning GLASSMAKER" tells more of the VYCOR story—and more about the heat lamp, too. We'll be glad to send you a copy.

CORNING GLASS WORKS
Corning, N. Y.

Corning means research in Glass

CORNING GLASS WORKS, Dept. PE-10, Corning, N. Y.
Please send me a copy of the material checked:
"Glass—its increasing importance in product design".....
"Corning GLASSMAKER".....
Name..... Title.....
Company.....
Address.....
City..... Zone..... State.....

THIS SUPER Seal

(EXCLUSIVE IN SEALMASTER BEARINGS)

obsoletes old ideas on bearing maintenance costs

IT KEEPS dirt out AND grease in!

When dirt gets into bearings or grease leaks out, you've got trouble . . . high maintenance and replacement costs and all-too-frequent disassembly and downtime for machines.

Permanently Sealed SEALMASTER Bearings Were Developed to Lick This Problem

HERE'S WHY: In SEALMASTER Bearings, grooved, steel inner seals—permanently mounted on the outer race ring, one on each side, form the grease chamber.

Two annular felt-lined flingers rotating with the inner race ring and within the grooves of the inner seals, form the outer seals. The centrifugal action of these flingers effectively seals out all dirt. The bottom flanges of these rotating flingers, passing under and slightly beyond the inner seals, create a vortex action in the grease chamber. This breaks up the grease flow and retains just the right amount of grease to lubricate.

Whether your problem is dirt or simply making sure the bearings in the machines you make or use will give maximum service, SEALMASTER Bearings can help *you*. They are first class assurance of low maintenance costs and long bearing life! Write for Bulletin No. 845.

SEALMASTER

BALL BEARING UNITS

SEALMASTER BEARINGS

9 Ridgeway Avenue, Aurora, Illinois

A DIVISION OF STEPHENS-ADAMSON MFG. COMPANY

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

Another Cylinder Application from the Engineering Files of

HANNA

TYPE OF APPLICATION	
PUSH	PRESS
PULL	CLAMP
LIFT ✓	CONTROL
LOWER ✓	

SMOOTH OPERATION OF A 500 LB. FURNACE DOOR

Hanna Fluid Power Cylinders are used in many ways to increase production, cut cost and save labor in thousands of power motion applications. They can improve performance both in your plant and in your products.

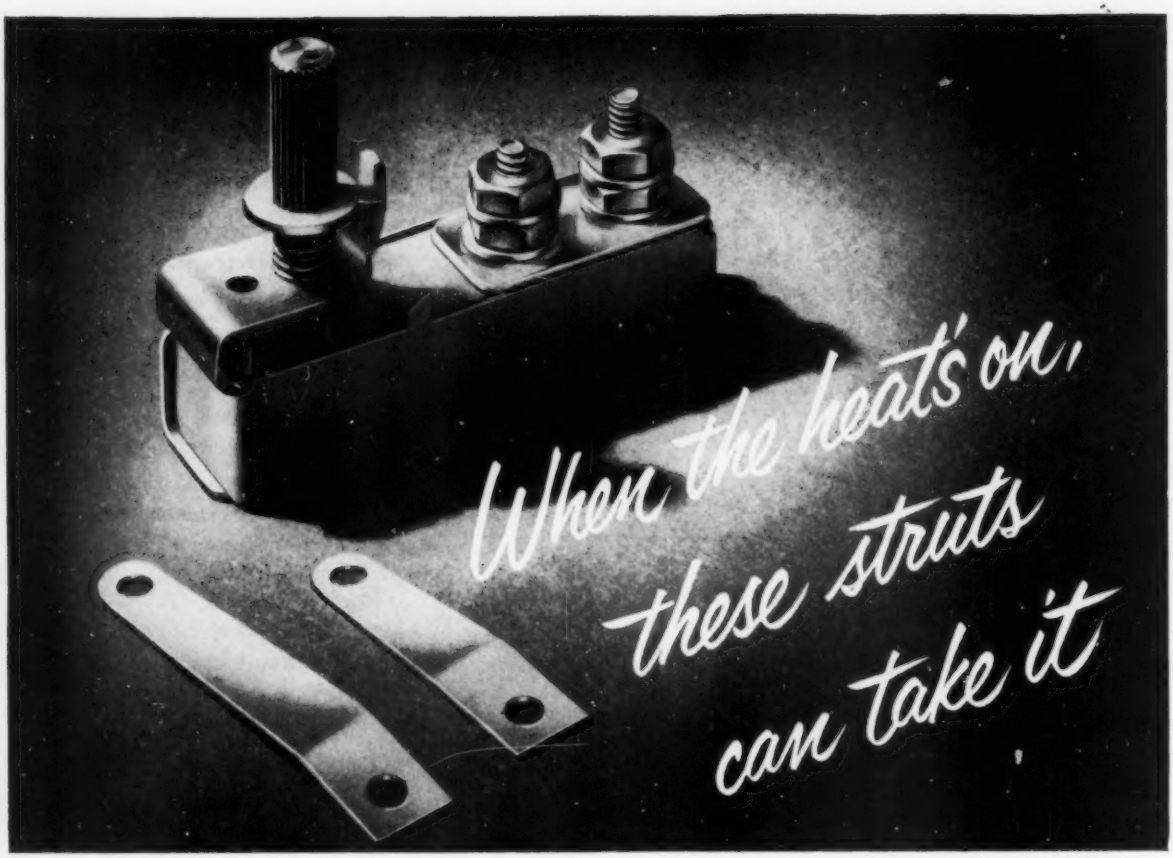
Hanna offers the advantage of skilled engineering service to insure maximum performance and economy—PLUS a complete selection of many types and capacities of hydraulic and pneumatic cylinders in a wide range of mounting styles.

Your local Hanna Representative can help solve your toughest power motion problems. His name is listed in your classified telephone directory. Call him today or write for details on Hanna Cylinder Engineering Service.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT • CYLINDERS • VALVES • RIVETERS

1763 Elston Avenue • Chicago 22, Illinois



*Product of Fenwal Incorporated, Ashland, Mass

THEY'RE MADE OF BERYLCO BERYLLIUM COPPER

These Berylco parts are struts—or contact supporting members—used in Fenwal's low-temperature appliance switch.*

This appliance switch is a practical, sensitive and accurate device for controlling temperatures. In household irons, for instance, it is used to provide a range of 50 to 300°F. It maintains constant temperatures for such appliances as pasteurizers and dryers.

The qualities demanded in this application—elasticity and thermal and electrical conductivity—are such that no other material would do. It is a must that the strut return to its original shape when tension on it is released. No other material with the desired electrical conductivity can provide these deflection characteristics at the temperature involved. Thermal conductivity is also desirable—to enable the heat developed by the contact points to be dissipated.

The unique properties of Berylco—its combination of strength and conductivity, its marvelous spring properties, its endurance, its ready formability—are making better, cheaper products for hundreds of manufacturers the country over. If you would like to include Berylco in your plans for the future, we invite you to share the know-how of the world's largest producer of beryllium copper. For engineering help or sample material, call or write any of the offices listed below.

THE MOST COMPLETE LISTING of available beryllium copper forms is contained in the recently published Berylco *Product Directory*. Send for your free copy today.

TOMORROW'S PRODUCTS ARE PLANNED TODAY—WITH BERYLCO BERYLLIUM COPPER

BERYLCO THE BERYLLIUM CORPORATION

DEPT. 3J, READING 2, PENNSYLVANIA

New York • Springfield, Mass. • Rochester, N.Y. • Philadelphia • Cleveland • Dayton • Detroit • Chicago • Minneapolis • Seattle • San Francisco • Los Angeles

Representatives in principal world-trade centers

*4 WAYS to help speed defense production

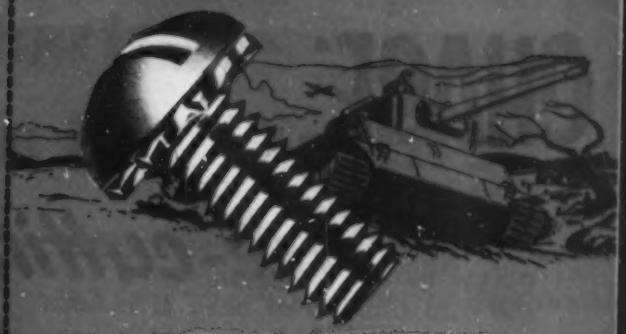
You'll find SHAKEPROOF fastenings at many vital connection points on modern military equipment . . . from tanks to walkie-talkies. Those shown here, and hundreds of others, are used by the millions by leading manufacturers because they save assembly time and assure dependable performance. Whether your plant is engaged in military or civilian production—or both—Shakeproof engineers are at your service to help your staff develop fast, economical and acceptable solutions to specific assembly problems. Call them in today.

SHAKEPROOF®

"Fastening Headquarters"

DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois • Offices in principal cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

America's Great Resources Plus A Free Economy Made This Business Possible!



*** SEMS-by-SHAKEPROOF**

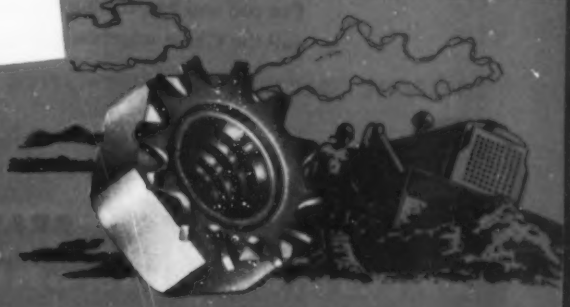
. . . pre-assembled screws and SHAKEPROOF Lock Washers eliminate separate washer handling, save assembly time.

*** SHAKEPROOF® THREAD-CUTTING SCREWS**

. . . cut their own threads in metal or plastic, positively eliminate costly tapping operations.

*** SHAKEPROOF® LOCK WASHERS**

. . . hold vital connections tight, reduce equipment failures due to loose fastenings.



*** KEPS®**

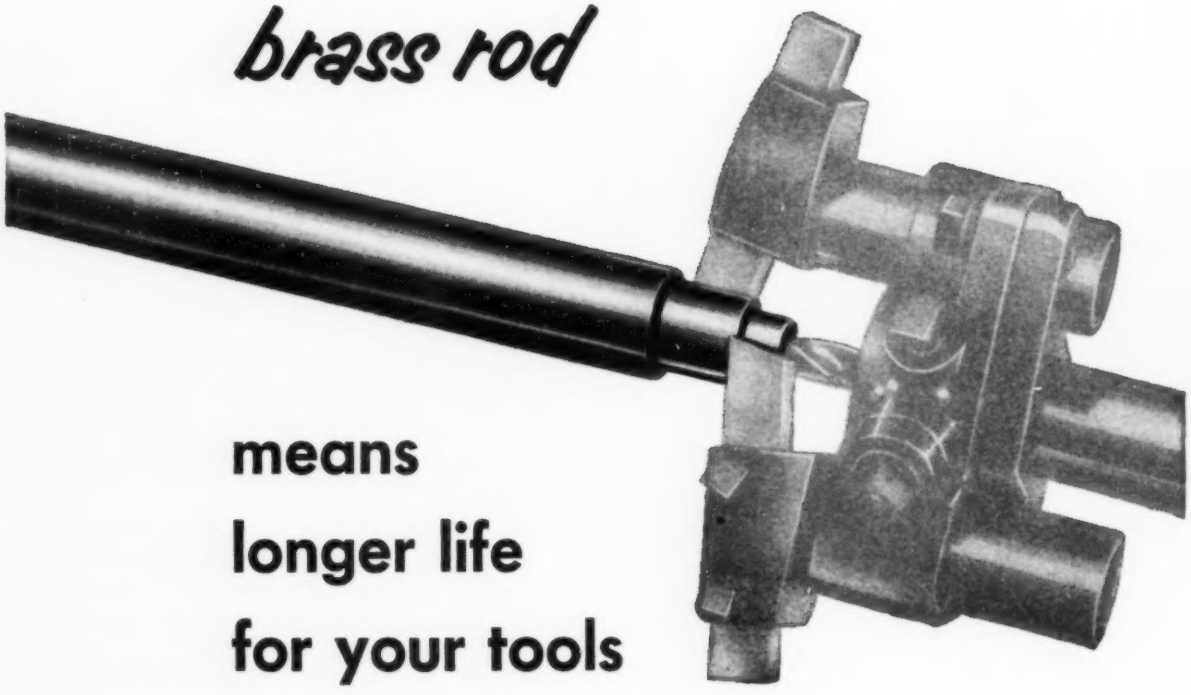
. . . speed assembly operations because nut and lock washer are pre-assembled . . . every nut is locked against vibration loosening.

Free... TESTING SAMPLES

Samples of the Shakeproof products illustrated here are available on request. Make your own tests and see how you can save. Write today . . . specify the samples you want by name.

CHASE®

free-cutting brass rod



means longer life for your tools

Chase Free-Cutting Brass rod yields short chips as it is machined. The result is much easier cutting, longer tool life. Products produced are smoother, cleaner-surfaced, less expensive to buff or polish before lacquering, enameling or plating.

Fine quality Chase rod and drawn bar are available in a wide variety of free-cutting copper alloys. They are always uniform so that repeat orders have the same cutting characteristics.

For rod and bar, for finer products at lower unit cost, call the Chase warehouse nearest you.

Chase® BRASS & COPPER

The Nation's Headquarters for Brass & Copper

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Denver†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston	Newark	Rochester†	(†sales office only)
Cincinnati	Indianapolis	New Orleans	St. Louis	

There is No Substitute For a Spring Washer

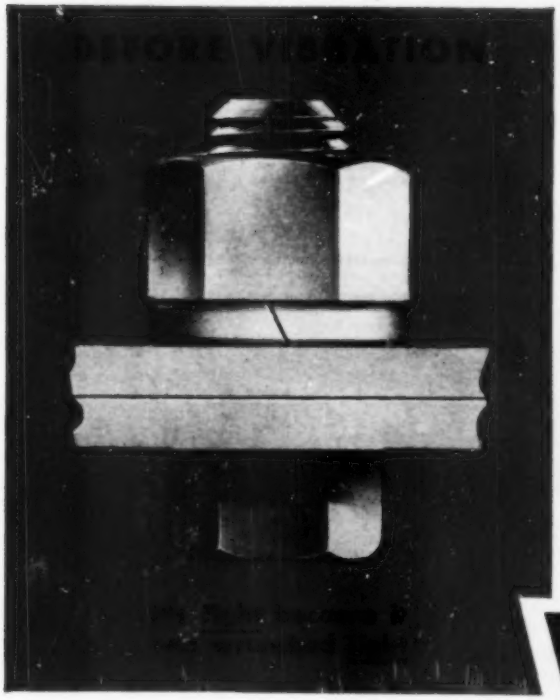
Every practical man knows that wear occurs when vibrating metal contacts metal; even when seemingly bolted tight.

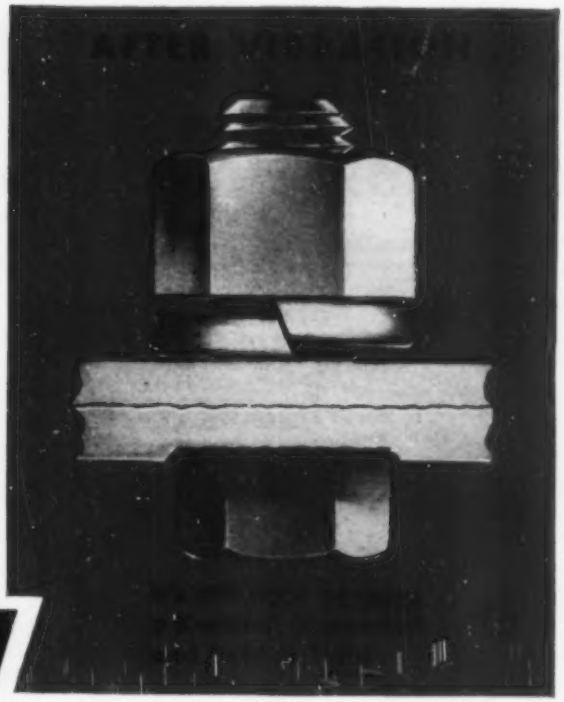
He knows that bolted assemblies loosen because of bolt stretch, and the frictional wear of burrs, flares, and the pulverizing of paint, scale and rust.

He knows that even if the nut never budges, the other parts of assemblies wear loose unless a strong spring washer is used to expand as wear occurs—to expand continually, over long range if necessary, to hold all parts tight longer.

There is no substitute.

On all assemblies specify Kantlink spring washers for real bolted security.

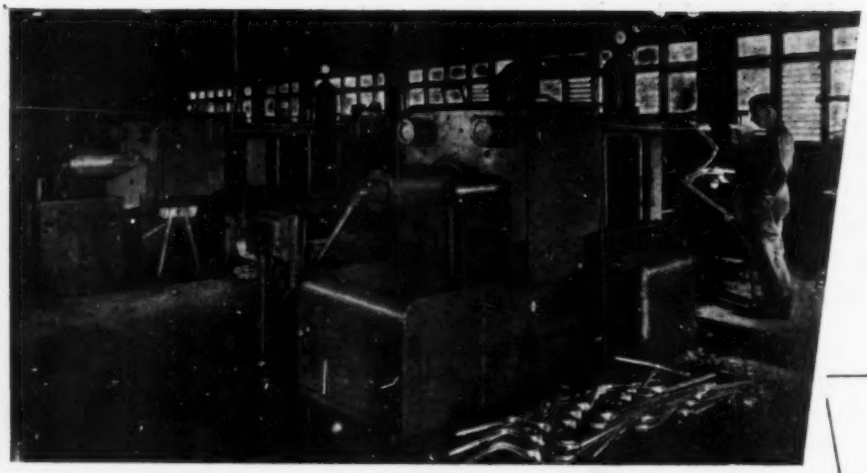




Originators of KANTLINK the long range spring washer

THE NATIONAL LOCK WASHER COMPANY

Newark 5, New Jersey — Milwaukee 2, Wisconsin



PECO PRODUCTS

It may seem like kids' stuff to you -

but it requires a high standard of precision die-casting to produce this aluminum furniture

PECO DIE-CASTING MACHINES

School desks and chairs, light, strong, comfortable, are made in thousands to-day by the Educational Supply Association, using PECO Die-Casters in their production. PECO Die-Casting Machines represent the finest result of technical design, embodying, amongst other characteristic features, electrical control which covers every movement of the cycle.

Full description in leaflets, available on request.

THE PROJECTILE & ENGIN ERING COMPANY LTD.

ACRE STREET, BATTERSEA, LONDON, ENGLAND S.W.8

Telephone: Macaulay 1212 Telegrams: "Profectus, Claproad, London" Cables: Profectus London

protect your machinery with

maintenance free **LOVEJOY**

FLEXIBLE COUPLINGS

When you install Lovejoy Flexible Couplings you get more than just long-lasting smooth power transmission. You get maximum protection against surge, backlash and starting torque. You get reduced down-time and less maintenance, since cushions can be changed without shutdown and Lovejoy Flexible Couplings *never* require lubrication.

Accurately machined bodies and jaws and cushioning materials engineered to the load conditions are combined in a compactly designed coupling to keep your machinery running better . . . longer.

Types and sizes for all applications

Send for complete catalog . . . contains full technical data and handy selector charts for your convenience. Yours without obligation.

LOVEJOY FLEXIBLE COUPLING CO.

5073 West Lake St. Chicago 44, Ill.

WHEN YOU NEED *COOLANT*

YOU NEED A RUTHMAN **GUSHER** COOLANT PUMP

This Special Chamfering Machine manufactured by the Cleveland Tapping Machine Company is equipped with a Gusher Coolant Pump.

On any cutting operation that demands the use of a coolant, a Gusher Coolant Pump offers you efficiency, dependability, and long trouble-free life. You get split second flow of coolant from the moment the machine is turned on. There is no packing or priming necessary. The simple construction, electronically balanced rotating shaft and heavy-duty pre-lubricated ball bearings of Gusher Coolant Pumps assure you dependable service. Write us today, we'll be glad to send you full information on types and models of Gusher Coolant Pumps.

THE RUTHMAN MACHINERY CO.

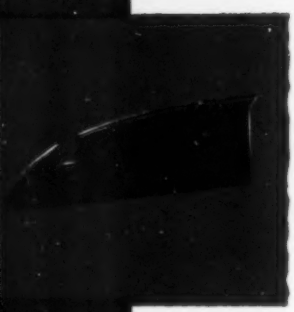
1818 Reading Road Cincinnati, Ohio

ROLL FORMED SHAPES
● Made to your design and production requirements with high-production equipment.
● Continuously formed from carbon, galvanized or stainless steel, aluminum, copper, zinc and cladmetals.
● Available in 8-inch to 24-ft. lengths.
● Deliveries when and where you want them.
Roll Formed engineers are constantly devising new methods and processes for metal forming. Consult them regarding your requirements. Send prints or parts for prompt quotation. Write for the new Roll Formed Catalog RF 1053.
ROLL FORMED PRODUCTS COMPANY
MAIN OFFICE AND PLANT
3760 OAKWOOD AVENUE
YOUNGSTOWN, OHIO

AICO *Reinforced* MOLDED PLASTICS

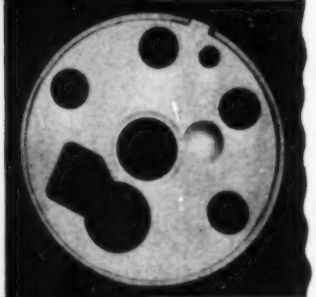
They're Extra Strong

Glass Fiber Preforms offer great strength and dimensional stability for tote boxes, trays, containers and similar articles.



They're Light

Fiberglass Cloth formed into aircraft fairings and fin caps offer exceptional strength-weight ratio. Smooth finish; high flexural, impact and tensile strengths is the perfect combination for many applications.



They're Highly Versatile

Glass Fiber Mat Molding forms radar cover 51" in diameter. Complex shape achieved without hand work or punch press.

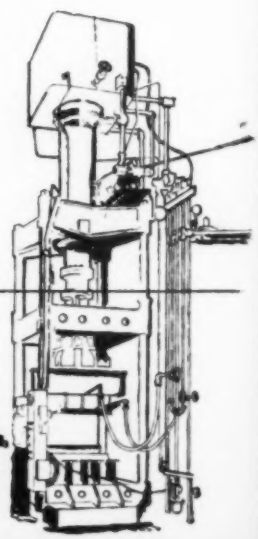
free booklet

GIVES PHYSICAL PROPERTIES
SHOWS TYPICAL APPLICATIONS

Molded Reinforced Plastics such as AICO #100 are non-conductive to electrical current . . . offer extreme heat and flame resistance. In addition to being light, strong and adaptable, Molded Reinforced Plastics are highly resistant to the deteriorating effects of weathering, oils and acids. That's why they can do jobs no other materials can handle . . . cut finishing and fabricating costs without reducing product quality. For all the facts on "What You Should Know About Molded Reinforced Plastics" . . . mail coupon for your free copy of this valuable booklet today.

A Complete Molding Service

AICO's complete plastic molding service includes: Engineering Counsel; Mold Building; Injection; Compression and Cold Molding plus the molding of Reinforced Plastics. AICO's new 100 ton press, shown in sketch, can produce reinforced plastic parts as large as 2' x 4' x 4'.



AMERICAN INSULATOR CORP.
New Freedom, Pennsylvania

Send me your free booklet on Aico Reinforced Plastics.
☐ Include your free Aico Plastics Applicator.

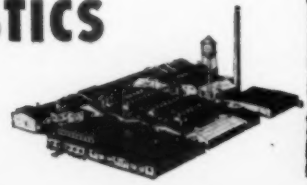
NAME: _____

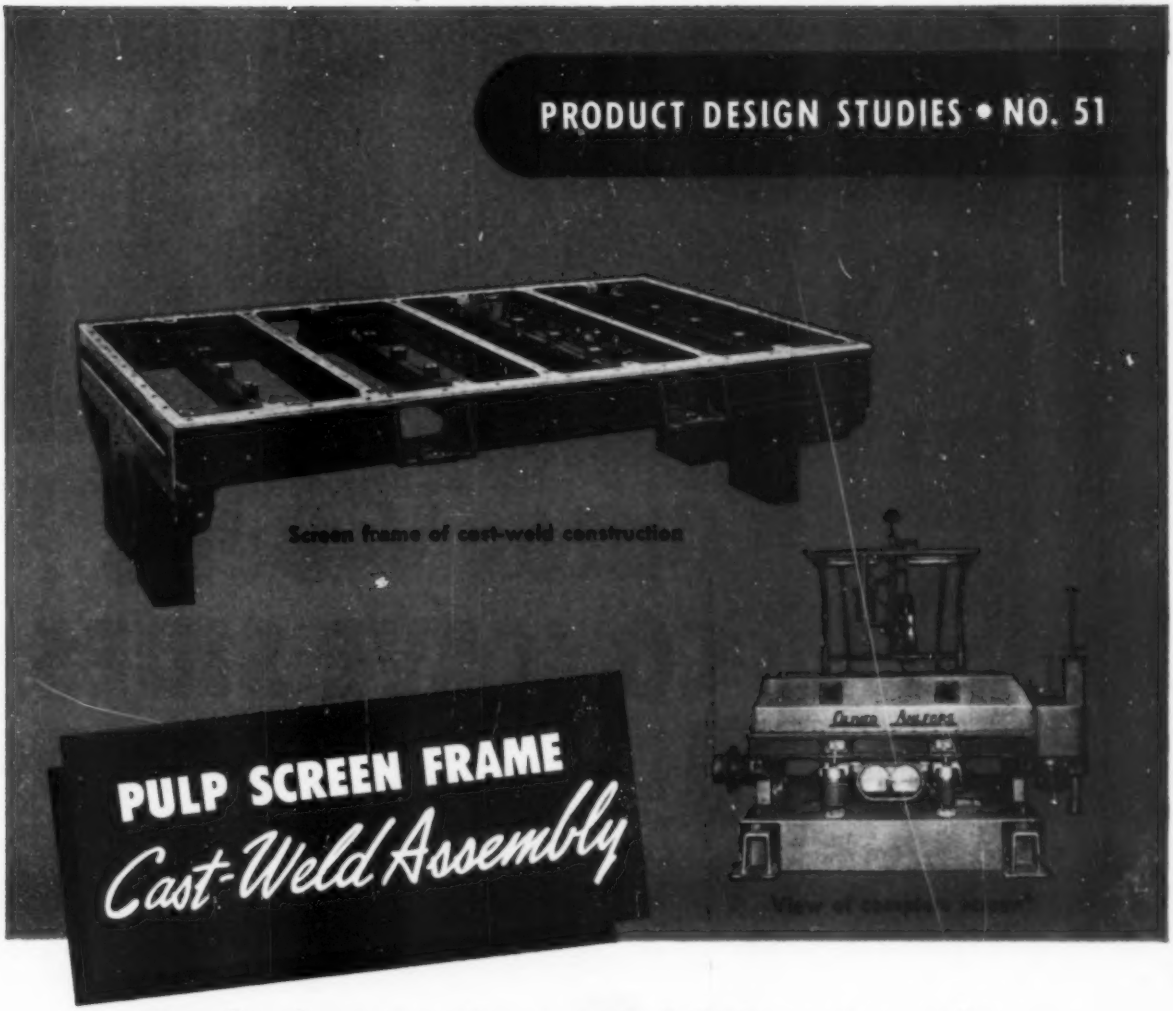
COMPANY: _____

POSITION: _____

ADDRESS: _____ STATE: _____

AICO plastics





Redesign to Cast-Weld Construction Cut cost 12%, increased durability

The pulp screen frame is part of the piece of equipment shown above used in paper mills for processing wood pulp.

Originally of bolted construction, the frame required expensive machine work and fastenings. Through cooperation of the manufacturer's engineering department and the steel foundry the frame was redesigned to cast-weld construction.

Conversion to cast-weld construction reduced the cost of the frame 12% and made it stronger—advantages which benefited both the manufacturer and his customers.

* * *

Here is another example of the foundry cooperation which is resulting in lower costs and improved products through redesign to steel castings.

This service is offered without cost or obligation. It makes available through your foundry representative the full results of the development and research program carried on by the Steel Founders' Society of America.

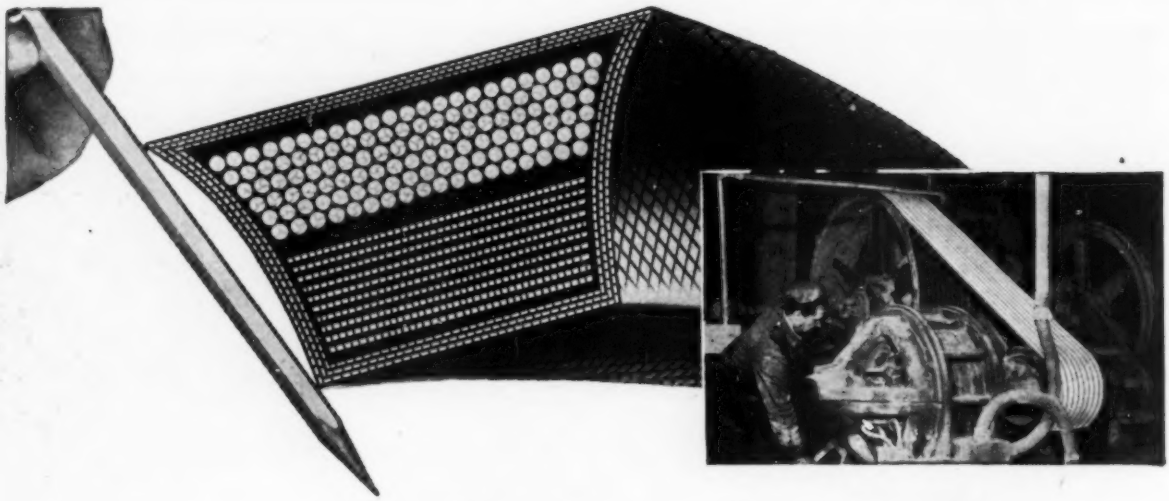
*Oliver-Ahlfors Upflow Vibratory Pulp Screen

51 YEARS OF SERVICE TO INDUSTRY

STEEL FOUNDERS' SOCIETY OF AMERICA

920 Midland Building — Cleveland 15, Ohio

Design and Build With Steel Castings

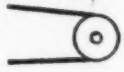


Gates V-Belts *are built with* CONCAVE SIDES

(U.S. PATENT NO. 1813698)

...that's why they last longer!

If you want lower V-Belt costs, just make this simple test...pick up *any* V-Belt and bend it as if it were going around a pulley.



As the belt bends, grip its sides between your fingers and thumb.

If the belt has *straight sides* you feel the sides bulge out. This forces the sides of the belt to press *unevenly* against the V-pulley . . . and you get concentrated wear at the points shown by the arrows.

Now, try this same test with the V-Belt that is built with CONCAVE SIDES **—the Gates Vulco Rope.**

As this belt bends, you can feel the CONCAVE SIDES *fill out* and become perfectly straight.

These sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the full width of the Gates Vulco Rope and the CONCAVE SIDES therefore mean longer belt life and lower V-Belt costs for you.

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the Gates Vulco Rope!

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

CS-935

V-Belts — Hose
Molded Rubber Goods
for industry
World's Largest Maker
of V-Belts

Gates® VULCO ROPE DRIVES

THE GATES RUBBER COMPANY • DENVER, U.S.A.

Half mile of HELIARC TRADE MARK welds OK'D by rigid X-ray tests

A midwest manufacturer was faced with the problem of getting X-ray quality welds in aluminum vessels. These welds were subject to pressure and had to be entirely free from porosity and oxide inclusions. After thoroughly investigating customer specifications, LINDE's service engineers recommended HELIARC inert gas shielded welding for the job.

Since then, about a half mile of these HELIARC welds have been OK'd by 100% X-ray inspections. According to company officials, HELIARC welding was "perfect for the job" and meant real savings by getting X-ray quality welds the first time without expensive rejections or repairs.

Whether you weld aluminum or other hard-to-weld metals, you, too, will find that fast, clean, HELIARC welding will save you time and production costs. HELIARC welding takes place under a shield of inert argon gas which eliminates the need for flux. As a result, HELIARC welds are free from porosity and oxide inclusions. This means fewer rejects and lower finishing costs. In fact, spatter-free HELIARC welds in many cases can be left "as welded."

You owe it to yourself and to your Company to find out more about the cost saving benefits of HELIARC welding. Call your local LINDE representative today. He will be glad to furnish you with detailed information on HELIARC welding.

LEFT Welding heavy aluminum sections with HELIARC *HW-10 torch. These welds were strong, dense, and required little finishing. BELOW The 300 amp.* HELIARC *torch has all-internal water-cooling of both torch head and power cable for cool, long-lasting operation. The HW-10 also features quick electrode adjustment.*

Linde TRADE-MARK

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

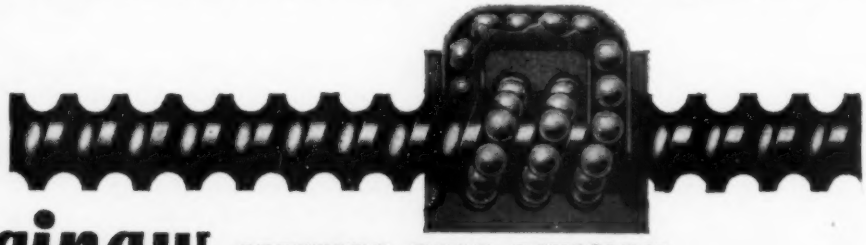
30 E. 42nd St., New York 17, N.Y. UCC Offices in Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

"Heliarc" and "Linde" are registered trade-marks of Union Carbide and Carbon Corporation.

Saginaw BALL BEARING SCREWS INCREASE EFFICIENCY OF FRAUENTHAL DOUBLE HEAD PRECISION GRINDER

Six Saginaw Ball Bearing Screws, two vertical feed screws, two horizontal feed screws and two cross rail elevating screws, help insure the remarkable efficiency and accuracy of the Frauenthal Double Head Grinder, a heavy duty precision grinding machine for internal, external and surface grinding of large diameters to tolerances within 200 millionths of an inch. Saginaw Screws permit the operator to keep the heads under easy control and raise or lower the cross rails effortlessly, because these reliable screw mechanisms transmit the rotary to linear force through rolling steel balls. Operating at 90% efficiency, they give virtually friction-free service and unusually long life with no maintenance other than simple lubrication. As linear actuators in automotive steering mechanisms, in the latest military aircraft, in machine tools and hundreds of other applications, Saginaw Screws are raising, lowering, pushing or pulling loads up to thousands of pounds with only a fraction of the torque required for ordinary thread-to-thread screws. They can be combined with electrical, hydraulic or pneumatic units. Saginaw Screws can be supplied in any size in a complete range of load and life requirements. For complete information, write for our free engineering data book.



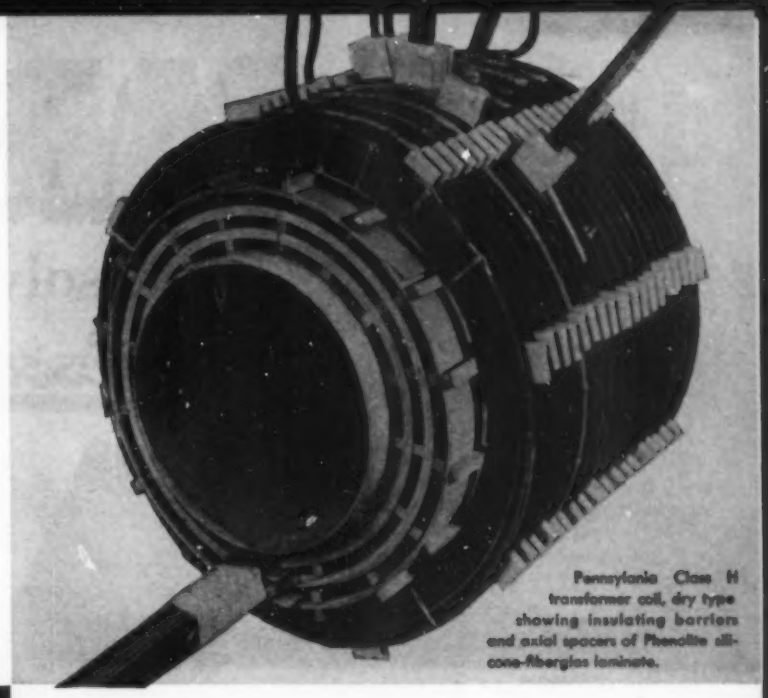
62

Saginaw STEERING GEAR DIVISION

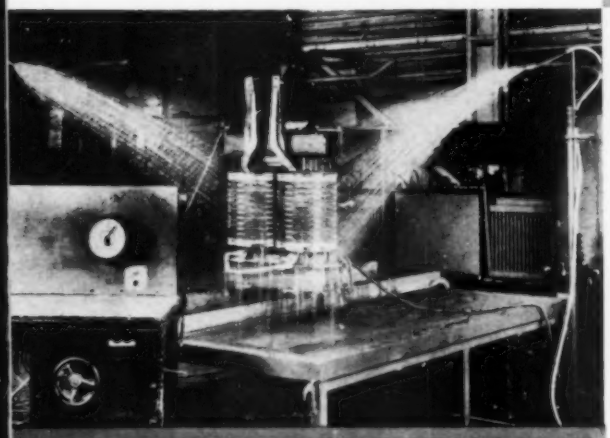
GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN • MANUFACTURERS OF SAGINAW POWER STEERING

class h insulation by National Vulcanized Fibre Co.

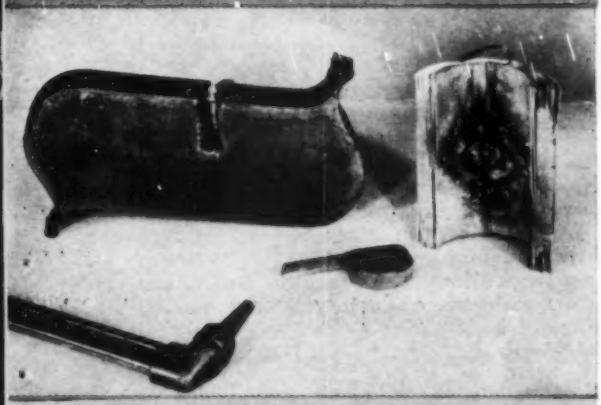
used by Pennsylvania Transformer Co. to build new, safe, and reliable Sealed Dry Type Transformers



Pennsylania Class H transformer coil, dry type showing insulating barriers and axial spacers of Phenolite silicone-fiberglas laminate.



Transformer core and coil assembly under full voltage excitation withstands heavy water shower. The insulation resistance remained at infinity megohms during the entire two-hour water test.



Class H insulation resists fire and combustion. The heat of the 5000° F. Oxygen-Acetylene torch, applied for the same interval, burned through the 2-inch steel plate, yet merely melted some of the glass fabric in the barrier.

Using Class H insulation (Phenolite silicone-fiberglas laminate), the Pennsylvania Transformer Company (a McGraw Electric Co. Division) builds Sealed Dry Type Transformers having many superior and safe operation features. The Class H Insulation eliminates the hazards of fire and explosion, permits up to 50 per cent weight reduction, makes possible efficient operation in humid atmosphere, reduces maintenance, allows operation at high temperatures, and permits frequent overloads. The coil barriers are made from 1/32 inch silicone sheets bonded with silicone rubber. The sheets are rolled directly onto the lathe during the coil winding operation, saving the high cost of a mandrel. Ideal for station auxiliary, unit substation and network service, these Sealed Dry Type Transformers are an outstanding example of National cooperative engineering and research. Perhaps you have an insulating problem where National Vulcanized Fibre Company can give you real help in solving your particular problem . . . economically. Write us—our engineering service is immediately available.

National laminated plastics
nationally known—nationally accepted

NATIONAL VULCANIZED FIBRE

PHENOLITE Laminated PLASTIC

NATIONAL VULCANIZED FIBRE COMPANY
Wilmington, Delaware

Since 1873

Offices in Principal Cities

CARMET

can solve *YOUR* *Wear-Resistance* problem

● WHAT JOBS HAVE YOU FOR CARMET CARBIDES TO DO?

For maximum wear, save with Carmet—preformed to practically any shape or size! *Examples:* entire blanking die parts; inserts for drawing, heading, extruding and blanking dies; gauge and wear parts, pins, bushings, etc. *Supplied Preformed* —with minimum grind stock allowed, or precision ground and ready for use. Let us work with you . . . send us your drawings and specifications for quotations. ● *Allegheny Ludlum Steel Corporation, Carbide Alloys Division, Wanda and Jarvis Avenues, Detroit 20, Mich.*

For complete MODERN Tooling, call

Allegheny Ludlum

AL
FINE TOOL STEELS
SINCE 1854

W&D 8468

ICE-FREE FUEL

FOR THE BOEING STRATOJET...

Even at high altitudes and sub-zero temperatures, the possibility of water moisture freezing on fuel filters presents no problem aboard the Boeing B-47. Equipped with a Lear-Romec Pump and Regulator, each of her six engines receives an automatically regulated supply of alcohol that prevents icing, assures an uninterrupted flow of fuel.

Equipped with explosion-proof motor, and secondary seal between motor and pump, this unit incorporates triple assurance against fire hazard. A special Lear-Romec Regulator or Flow Control Valve automatically limits capacity of pump to the required maximum, regardless of pressure in the fuel filter.

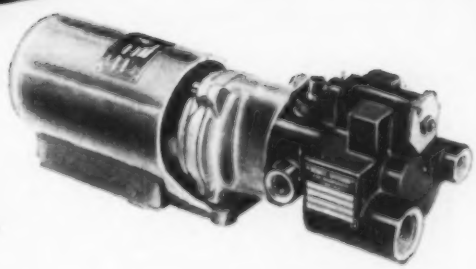
New items offering broad application possibilities are constantly being added to the comprehensive Lear-Romec line of Fluid System Components. For detailed information, write for the latest Lear-Romec catalog.

AIRCRAFT PRESSURIZING PUMPS

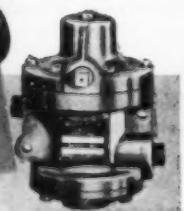
ENGINE-DRIVEN FUEL PUMPS

MODEL RG-5490-C ALCOHOL PUMP—

0.143 hp; weight 4.3 lb; rated capacity 60 gph minimum at 35 psi, 100 gph maximum at 50 psi, limited by Pressure Regulator RD-10120 illustrated below.



HYDRAULIC AND OIL TRANSFER PUMPS



PRESSURE REGULATOR

Lear

Advancing the Frontiers of Flight

® LEAR-ROMEC DIVISION

ABBE ROAD, ELYRIA, OHIO

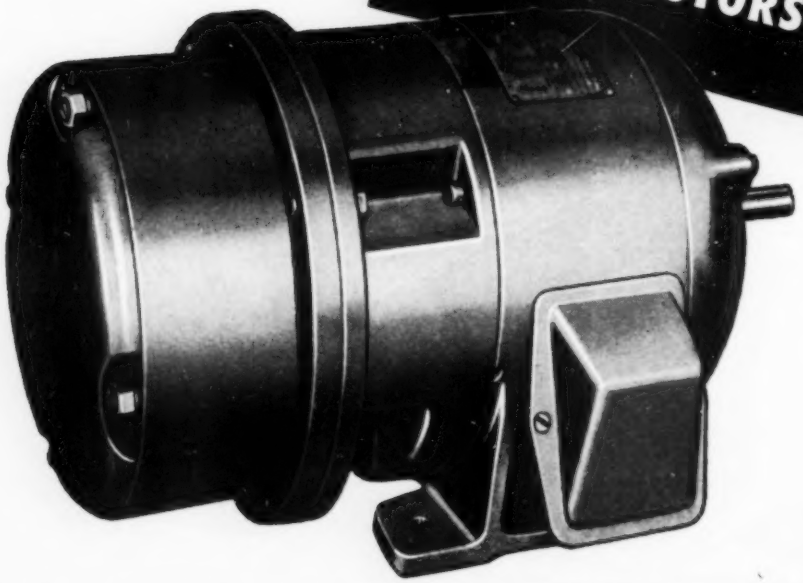
OTHER LEAR-ROMEC COMPONENTS:

Pressurizing Kits • Water Injection Pumps • Lubricating and Scavenge Pumps
Air Motors • Airborne Air Compressors • Centrifugal and Turbine Pumps
Camera Vacuum Pumps • Dehydrators • Absolute Pressure Switches
Radar Pressurizing Control Panels

LEARCAL DIVISION, LOS ANGELES, CALIFORNIA
LEAR, INCORPORATED, GRAND RAPIDS 2, MICHIGAN
GRAND RAPIDS DIVISION, GRAND RAPIDS 2, MICHIGAN

Split-second STOPS call for...

ELLIOTT CROCKER-WHEELER BRAKE MOTORS

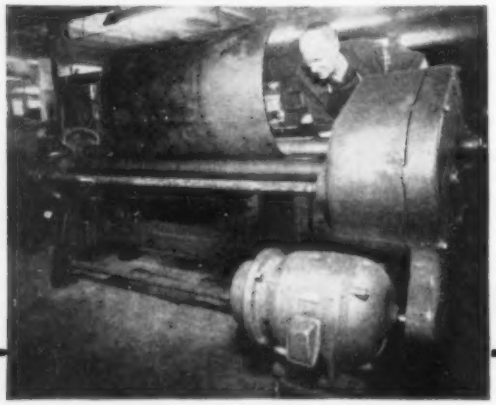


Here's a brake that has everything demanded of the most exacting service. Check over these valuable features:

NEW "CLOSE-COUPLED" COMPACTNESS that not only enables it to fit in limited space, as in machine tools and similar equipment, but also provides the rigidity and sturdiness to take the stress of constant sudden stoppage.

TORQUE ADJUSTMENT FROM THE OUTSIDE OF THE CASE.

TYPICAL APPLICATION — This roll-forming machine has to stop movement of the work exactly on a layout line. The Elliott Crocker-Wheeler brake motor does the trick.



PRACTICALLY NON-WEARING BRAKE ACTION, with metal-to-metal contact of "Velvetouch" discs and stationary plates for greater friction, quicker stops, and entire immunity to heat, cold, dampness, fungi, oil or grease.

QUICK-REMOVABLE WRAP-AROUND COVER enables inspection of all brake parts from the side of the brake.

SUPERIOR MAGNET CONSTRUCTION, up to the highest Crocker-Wheeler standards.

If you want a free-running brake that clamps down to an instantaneous dead-on-the-line stop when the power clicks off, this is it.

The Elliott C-W brake can be supplied with Crocker-Wheeler integral motor. It is also available as a separate unit for mounting on double shaft extension NEMA standard D flange motors, frames 203-326 or C face motors, frames 364-405. It needs no mounting brackets nor adapters.

GET THE BRAKE MOTOR BULLETIN

Ask your local Elliott field engineer, or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

CROCKER-WHEELER DIVISION

W3-1

TAYLOR ***Bone Grade Vulcanized Fibre***
is an extremely tough and dense grade of vulcanized fibre. It is excellent for applications where difficult machining operations are required . . . resistant to organic solvents, oils and gasoline . . . has excellent electrical characteristics.

Want to make something of it?

Make it into gears, cams, fairleads, bushings and grommets, slot wedges, threaded and tapped pieces, rail joint insulation and other applications where mechanical strength, good finish and intricate machining are required. Color: gray.

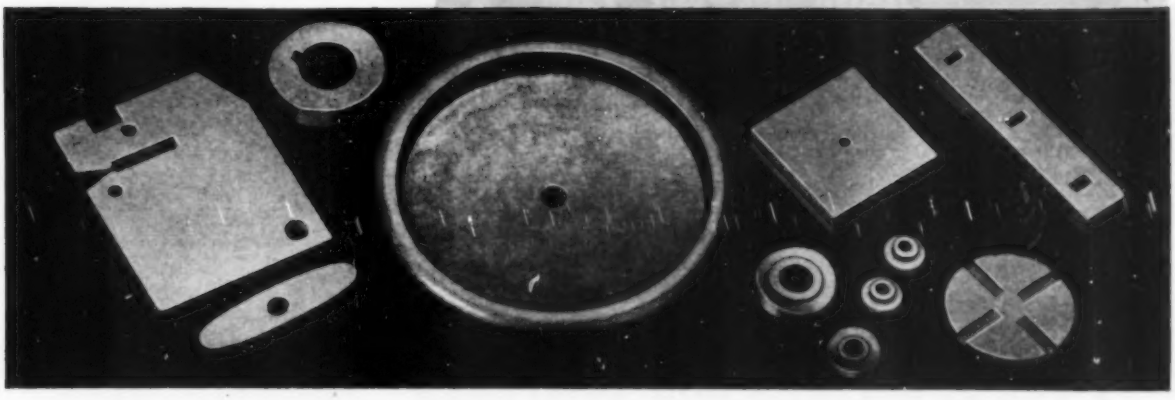
Make it from sheets or rolls with these specifications:

SPECIFICATIONS

Thickness range . . . 1/32" to 1/2"
Finish . . . Pressed and calendered
Punching . . Up to 3/16" thickness
Sheet size . . . Approx. 56" x 90"
Roll width . 56" for thicknesses of 1/32" through .060". Coils down to 7/32" for thicknesses of 1/32" through .090".

PROPERTIES

Mechanical			
Flexural Strength, psi		Izod Impact Strength, Ft.-Lbs./inch	
(Lengthwise)	14000 min.	(Lengthwise)	3.0
(Crosswise)	12000 min.	(Crosswise)	2.4
Tensile Strength, psi		***Electrical***	
(Lengthwise)	7500 min.	Dielectric Strength, VPM	
(Crosswise)	5500 min.	(1/32")	250 min.
Compressive Strength, psi		Short Time Test (1/8")	175 min.
(Flatwise)	30000 min.	Arc Resistance, seconds	100



Make it from turned rods. Diameters from 1/8" through 1/2" with ground or buffed finish.

Make it easy for yourself the next time you are looking for an extremely dense, abrasion resistant material. Call your Taylor Engineer . . . he will be glad to work with you . . . go over your requirements . . . and help you select the correct grade of Taylor Vulcanized Fibre to fit your needs—Bone, Commercial, Super White, Abrasive and Built Up. Ask him about Taylor Laminated Plastics, too. He will be glad to give you samples of *Phenol, Melamine and Silicone Laminates* for your inspection.

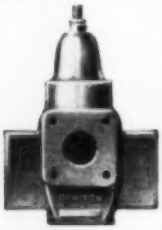
Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
Vulcanized Fibre

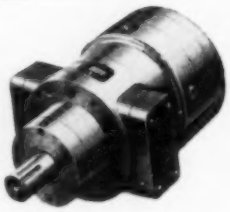
BUILT TO TAKE IT

longer, with less maintenance, at pressures up to 5000 psi

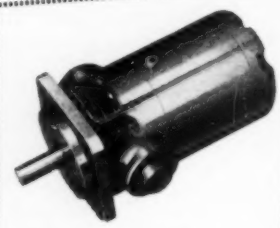
SURGE-DAMPING CONTROLS
Industrial and Aircraft Types
Eliminate Destructive Hydraulic Pressure Shock
¼" to 1" Sizes
For Pressures to 5000 psi
Catalog VS-1-A



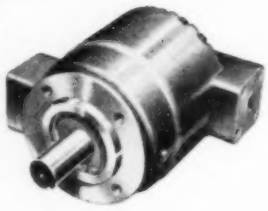
Direct-Operating PRESSURE CONTROLS
½" to 1½" Sizes
For Pressures to 2000 psi
Catalogs VRD-1 through VRD-8



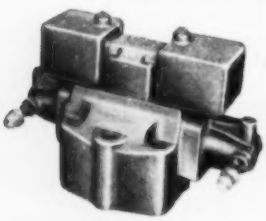
High-Pressure Axial-Piston PUMPS
Constant or Variable Volume
For 2500, 3000 and 5000 psi Circuit Needs
3.5 to 35 gpm Capacities
Catalogs P-4 through P-4-10



High-Torque Axial Piston FLUID MOTORS
Torque Ratings 13.8 to 112 inch-pounds per 100 psi (about 3 to 180 hp maximum)
For Pressures to 5000 psi
1500 to 3000 rpm
Catalogs FM-1, FM-2, FM-3-A



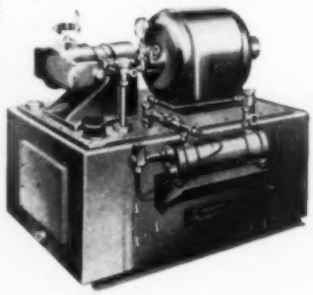
Dual-Purpose, Vane-Type PUMP/MOTOR
Ready for either pump or motor use without change
Shaft rotation in either direction
Four Sizes, 11 Models
Pumping Capacities: 3 to 82 gpm.
Motor Torque: 13 to 257 inch-pounds per 100 psi. Pressures to 2000 psi.
Bulletin P-5



DIRECTIONAL CONTROLS
Manual, Mechanical, Electric or Pilot Control. ¼" to 2" Sizes
For Pressures to 5000 psi
Catalog VD-3

PRESSURE REDUCING VALVES
¾" to 1½" Sizes
20 gpm to 65 gpm Capacities
For Pressures to 5000 psi
Catalog VPR-1

Multi-Range FLOW CONTROLS
Full-Scale Regulation—Adjustable for Varying Input
¼" to ¾" Sizes
For Pressures to 3000 psi
Catalogs VFC-1, VFC-2



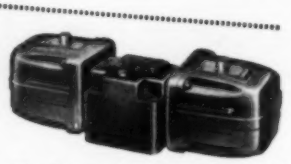
PUMPING UNITS
Constant and Variable Volume
46 Models—2 to 35 gpm Capacities
For Pressures to 5000 psi
Bulletins PU-3-A, PU-4 and PU-5

Denison HydrOILic PUMPS, MOTORS and CONTROLS

Proved in use—under many of Industry's toughest operating conditions—Denison HydrOILic Pumps, Motors and Controls are noted for their combination of high efficiency and rugged dependability.

In addition to fine performance under continuous, heavy-duty use, Denison HydrOILic Equipment offers space-saving design that simplifies circuit layout, makes installation easier, and minimizes maintenance problems.

Because so many users verify the extra value built into Denison Pumps, Motors and Controls, we continue the challenge made so often before—*let comparison prove to you* why they are first choice for so many needs of every type. Write today for full details on Denison HydrOILic Equipment to meet your requirements.



Pilot-Operated, Solenoid-Controlled DIRECTIONAL VALVES
Eliminate Spool-Sticking
¾" to 1½" Sizes, For Pressures to 5000 psi
Catalogs VD-1-1 to VD-4-2

Hydraulically Balanced PRESSURE CONTROLS
¾" to 2" Sizes
For Pressures to 5000 psi
Catalogs VR-2-B and VR-S-2

The DENISON Engineering Co.
1157 DUBLIN ROAD, COLUMBUS 16, OHIO

DENISON HydrOILics

"The Finest Money Can Buy!"

A wide variety of designs and sizes of sleeve bearings, cast bronze bushings, precision bronze parts, bi-metal and rolled split bushings, washers and spacer tubes. Research, engineering, quality control, large-volume production.

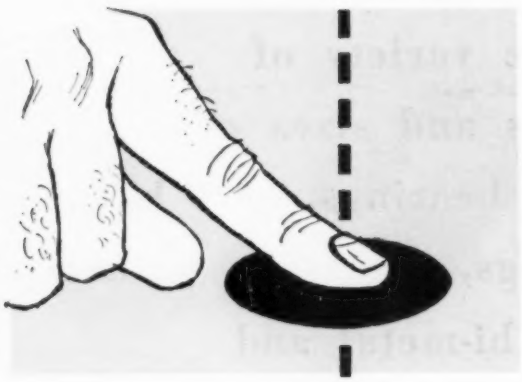
FEDERAL-MOGUL CORPORATION
11043 Shoemaker • Detroit 13, Mich.

FEDERAL Mogul
Since 1899

FEDERAL-MOGUL

Push button production

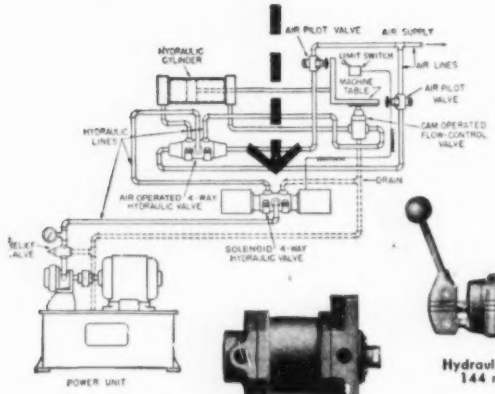
How near to its attainment are we?

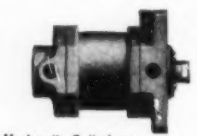


Very near! In fact, it is on the doorstep of every manufacturer, awaiting his planning the application of lately designed sources of power to his production processes. Some companies already have their plants on a nearly automatic basis, and the resultant cut in costs quickly pays for their investment.

Rivett is playing a part in this manufacturing advancement. Its air and hydraulic valves and cylinders are ideal power replacements for untold manual operations. And, more important, they are being used to power entirely original processes—offering tremendous short cuts in machining, forming, handling, finishing, etc.

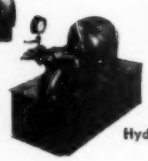
Remember, productivity is your sole source of success. Attain it! And the one best way is to follow the example of many progressive companies and plan the use of Rivett air and hydraulic power!



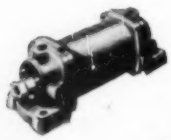


Hydraulic Cylinders
108 models

Hydraulic Valves
144 models



Hydraulic Power Units
17 models



Air Cylinders
84 models

Air Valves
34 models

AUTHORITIES — in applying air and hydraulic power

Baltimore, Md.—Colliflower, Inc., Baltimore National Pike, Ellicott City, Md.
Boston, Mass.—L. W. Sheehy, 1104 Park Square Bldg.
Buffalo, N. Y.—Lane Engineering, 1807 Elmwood Ave.
Chicago, Ill.—MacMillin Engineering, 1737 Howard St.
Cincinnati, O.—Seifreat-Elstad Machy., P.O. Box 2508
Cleveland, O.—Garco Machy., 21000 St. Clair Ave.
Columbus, O.—Seifreat-Elstad Machy. Co., P.O. Box 922
Dallas, Texas—Womack Mach. Supply Co., 6409 Maple Ave.
Dayton, O.—Seifreat-Elstad Machy., P. O. Box 332
Detroit, Mich.—Fors Sales Co., 2832 E. Grand Blvd.
Flint, Mich.—Shively Bros., Inc., 719 E. 2nd Avenue
Los Angeles, Calif.—Paul-Munroe Co., 4867 E. Gage Ave., Bell, Calif.
Milwaukee, Wis.—MacMillin Engineering Corp., 1737 Howard St., Chicago 26, Ill.
Minneapolis & St. Paul, Minn.—Anderson Machine Tool Co., 2641 University Ave., St. Paul.
Newark, N.J.—Compressed Air Products, 1977 Springfield Ave., Maplewood, N.J.
New York City—Compressed Air Products, 6 Church St.
Philadelphia, Pa.—The Battersby Co., 3701 N. Broad St.
Pittsburgh, Pa.—F. R. Magill Co., 44 McKnight St.
Portland, Oregon—Hydraulic Power Equip. Co., 2316 N. W. Savier St.
Richmond, Va.—Industrial Supply Corp., 15th & Franklin Sts.
Rochester, N.Y.—Genesee Machine Builders, Inc., 1732 Hudson Ave.
St. Louis, Mo.—William Scheer Co., 6376 Clayton Rd.
Salt Lake City, Utah—J. M. Grisley Mach. Tools, 375 S. W. Temple St.
San Francisco, Calif.—Ditzen Eng. & Sales, 5275 Claremont Ave., Oakland 9, Calif.
Seattle, Wash.—Hydraulic Power Equip. Co., 2316 N. W. Savier St., Portland, Ore.
Tulsa, Okla.—John G. Burke & Co., P.O. Box 1652
Toronto, Ontario—D. M. Duncan Machy. Co., Ltd., 197 College St.
Windsor, Ontario—D. M. Duncan Machy. Co., 1958 Wyandotte St.

Dept. PE-10 RIVETT LATHE & GRINDER, INC. • Brighton 35, Boston, Mass.

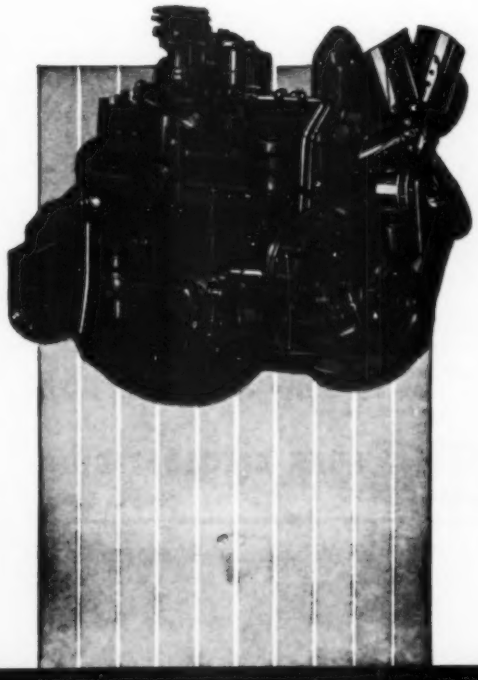
RIVETT furnishes a complete power package

VALVES • CYLINDERS • POWER UNITS

Air and Hydraulic
All sizes and types

Photo courtesy Wayne Manufacturing Company, Pomona, Calif.

Chrysler powers "One-Man Sanitation Department"



For only a few cents a mile—where it used to cost dollars—any community, plant or airport can keep its streets, parking lots or air-strips clean. Thanks to the combination of modern equipment and *modern* industrial power, what once was an expensive 3, 4 or 5 man job, is today done better, faster and at far less cost . . . by one man.

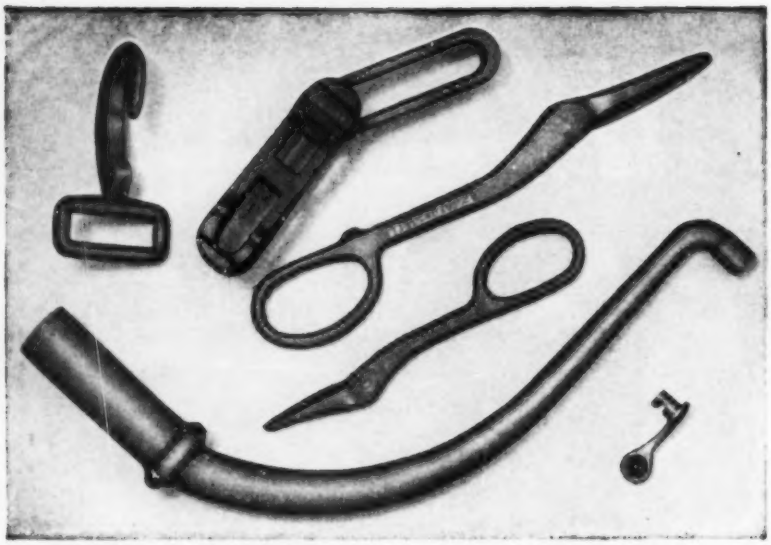
With power from a power-packed Model 8 Chrysler Industrial Engine equipped with heavy-duty, four-speed transmission, the Wayne Pick-Up Sweeper does everything in one operation. There's no need for others following behind to pick up dirt and truck it away. It sweeps up to 8 miles an hour, fills its own three cubic yard hopper as it goes along, and carries dirt away to the disposal point at traffic speeds.

This manufacturer, like others, selects Chrysler engines *equipped at the factory to meet his needs in the field.* Among the Chrysler options for his selection are gasoline, natural or liquid-propane gas burning carburetors, standard or gear driven front ends (with magneto or hydraulic pump drive), 12 or 24 volt electrical system.

See the Chrysler Industrial Engine dealer nearest you for complete information on Chrysler power. And remember, Chrysler engines are not expensive. Production-line methods, adapted to specialized Industrial Engine building, provide a custom-built engine at mass-production prices. If your problem is special, write: ***Dept. 410, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

CHRYSLER
Industrial Engines

HORSEPOWER WITH A PEDIGREE



REMEMBER

RITCO

DROP FORGINGS

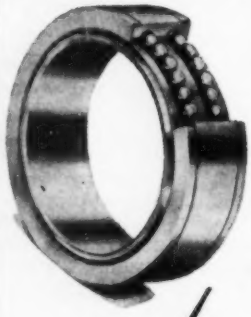
For maximum strength and accuracy of metal parts, Ritco Bright Finish Drop Forgings are outstanding. Smooth and free of flash, they are produced in steel or non-ferrous metals, in weights from ¼ lb. to 15 lbs. It pays to remember Ritco for drop forgings, special fasteners, and regular and heavy head finished body bolts . . . also for machining and grinding.

Send blueprints for free estimates. Rhode Island Tool Company, 148 West River St., Providence 1, Rhode Island.

Exclusive New England Representatives for Cleveland Cap Screws

★ SERVING AMERICAN INDUSTRY SINCE 1834 ★

Here it is



a BALL BEARING BUSHING offering maximum capacity in limited space

(only ¼" section height)

. . . provides stability, radial and thrust capacity in very light section.

. . . increases equipment life without adding excessive weight.

. . . improves performance without costly changes in design.

. . . prelubrication eliminates costly methods of introducing lubrication.

. . . a practical answer to many problems of designers and users.

Write for folder giving sizes and load capacities. Ask our Engineering Department for advice and assistance on your problems.

SPLIT BALLBEARING CORP.
LEBANON NEW HAMPSHIRE

IMMEDIATE DELIVERY of FUNK Gear Reduction Power Take-Offs

for Industry and Agriculture

in a wide selection of sizes, types and standard gear ratios!

In most cases we can fill your needs for Funk Gear Reductions from our large stock of standard types and gear ratios. Write for specifications, data and stock list of standard Power Take-Offs and Gear Reductions and ratios.

STRADDLE MOUNTED PINION

is featured on FUNK Gear Reductions—affording double support and eliminating misalignment.

SPECIAL RATIOS IN SMALL QUANTITIES

Funk is in a position to furnish special gear ratios and special adaptions of standard units in small quantities—no need to purchase more than you need.

FUNK AIRCRAFT CO.
3301 Airport Drive Coffeyville, Kan.

In hydraulic pumps

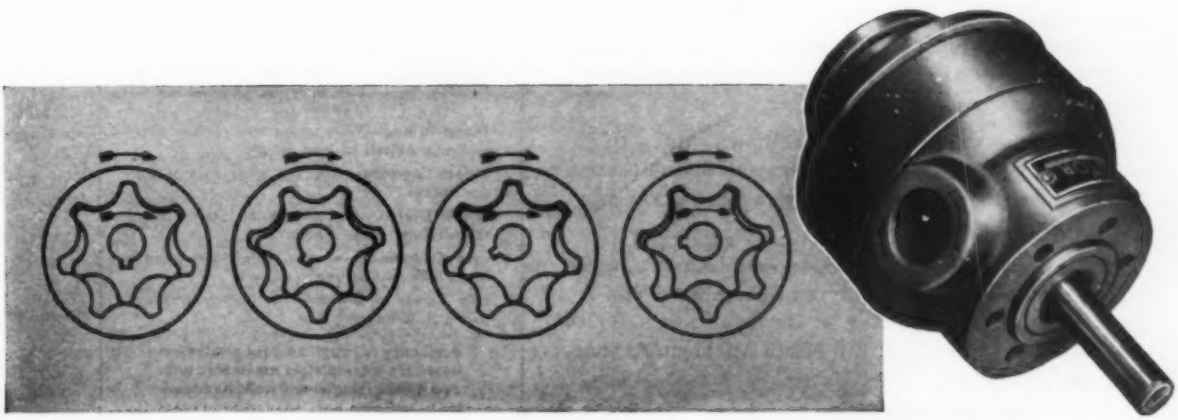
GEROTOR

is more than a name . . .

it's the principle of the thing!

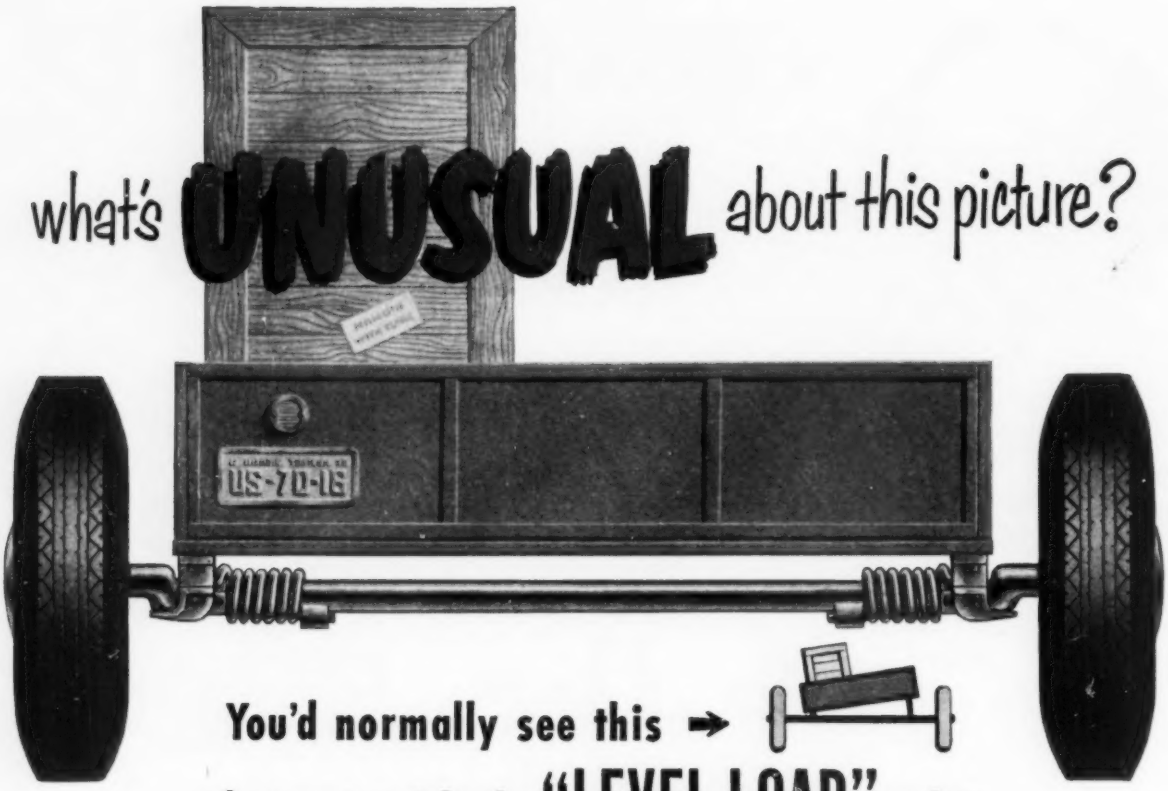
The unique Gerotor principle operates with high volumetric and mechanical efficiency. Both gear-shaped Gerotor elements revolve in the same direction at low relative speed, resulting in less wear, longer life. Continuous fluid-tight engagement means less slippage, more uniform flow. See relative advance of teeth and spaces below.

Gerotor hydraulic pumps are engineered for pressures up to 1000 p.s.i. continuous duty; in some sizes, up to 1200 p.s.i. continuous and 1500 intermittent. Deliveries range from .4 g.p.m. at 1800 r.p.m. to 40 g.p.m. at 1200 r.p.m. Plain, base or flange mounting. Write for pump catalog.
GEROTOR MAY CORP., P. O. Box 86, Baltimore 3, Md.



GEROTOR hydraulic pumps & motors

what's UNUSUAL about this picture?



You'd normally see this ➔

but not with the "LEVEL-LOAD" axle!

An axle that evenly distributes load weight on both springs—*regardless of load placement*—can't help but offer makers of towed equipment more freedom of design and layout. And it's here now . . . the ASF-Linco "Level-Load" axle!

Each end of this unique axle has a spring-controlled floating spindle arm, forged as a solid, integral unit with the steel shaft. Road shock on one wheel, or an off-center weight, is absorbed by both springs—*equally and simultaneously*. The inevitable result is a load that stays level without tilting or sidesway; a load that tracks better and pulls evenly on the drawbar.

And, as the spindle arm moves downward with increased loads, spring leverage *decreases*. Spring tension and load weight are automatically maintained in easy-riding proportion to each other!

If you design any kind of towed equipment . . . welding machines, sprayers, utility trailers, mixers, etc. . . . get all the facts on towing at its level best! Write American Steel Foundries, 410 North Michigan Avenue, Chicago 11, Illinois.

The NEW axle that adds NEW features to towed equipment!

Load Stays Level—No tip, no sidesway to cause uneven drawbar pull.

Easier Riding—With spring tension that automatically adjusts to load weight.

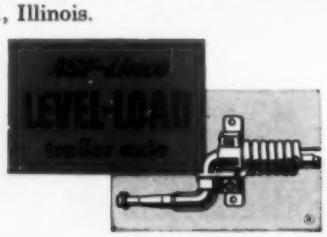
Bigger Capacity—Than any other axle of similar rating.

Simple Design—Eliminates spring leaves, shackles, snubbers, U-bolts.

Less Maintenance—Fewer parts to wear. Easily renewable friction bearing insert.

Low Center of Gravity—For greater stability, and a road-hugging ride.

And, easy to install on your production lines! It's a completely assembled unit. Just 4 bolts (single) or 8 bolts (tandem). No equalizing bars needed in tandem mounting.



AMERICAN STEEL FOUNDRIES

Moving mountains— with an assist from SYNTHANE

Have you a mountain to move? This big bucket, aided by parts machined from Synthane laminated plastics, does the job easily and quickly.

You can't see these parts in the picture but earth movers use Synthane for its electrical insulating properties, wear resistance, and mechanical strength. These and other properties *in combination* make Synthane an essential in industry.

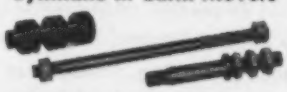
Electronic manufacturers "print" circuits on foil-clad Synthane sheets; aircraft designers approve Synthane's lightweight and strength; chemical people like its resistance to moisture, corrosives, solvents.

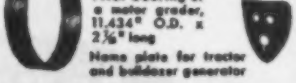
Synthane's combination of properties may give it a place in your product. Synthane is a light-weight material that holds its shape. It's tough, resilient—yet easily machined. It has good tensile, compressive, flexural, and impact strengths.

Are you planning a new product or ways to improve your present one? Consider Synthane. Write today for the Synthane Catalog. Synthane Corporation, 6 River Road, Oaks, Pa.

There are many kinds of plastics. Synthane belongs to a group called thermosetting, that is, stable over a wide temperature range. Synthane is sometimes called the "workhorse of plastics" since its combination of properties is especially valuable in industrial products, equipment or processes. The three principal forms —sheets, rods and tubes—are shown above.

Synthane in Earth Movers





Insulator and insulating bolts for power shovel

Pivot bearing of a motor grader, 11.434" O.D. x 2⅛" long

Name plate for tractor and bulldozer generator

Synthane-one of industry's unseen essentials

SYNTHANE

OAKS PENNA.

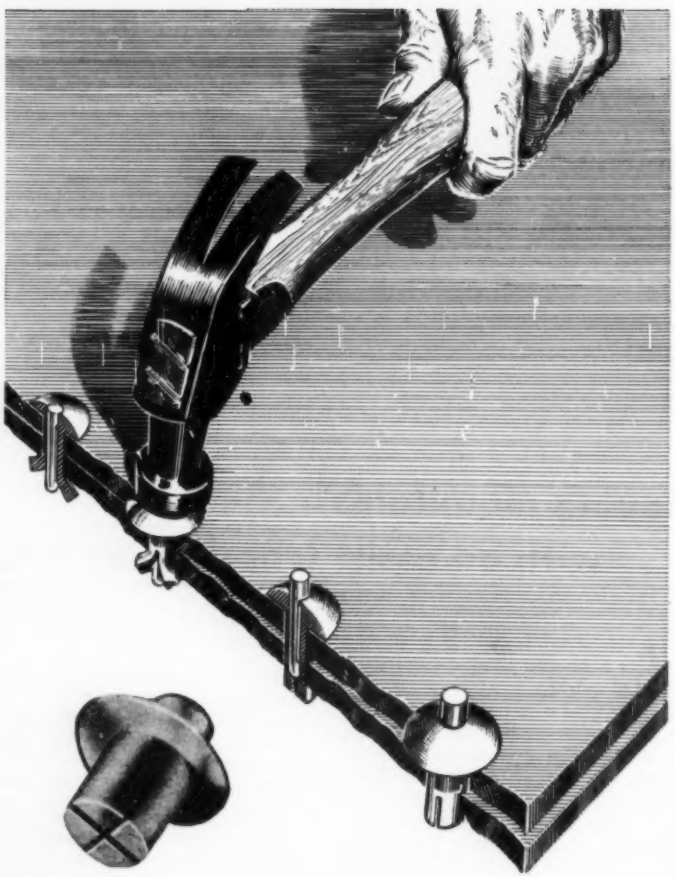
LAMINATED PLASTICS

WHAT IS A "BLIND" RIVET?

It is a type of fastener used to rivet together two or more pieces of material when access to the work is possible from only one side.

But SOUTHCO "Blind" Drive Rivets do much more than that. They provide maximum strength and reduce production costs. For installation you just hit the pin . . . and the rivet is in. At the same time, a powerful pull-up force is exerted to produce the kind of a tight joint you get when a rivet is bucked from both sides.

There is no finishing operation required with SOUTHCO Rivets, no wasted material, no noise, no special tools to buy or maintain. Fastening metal parts is as simple as driving a nail.



FOR EITHER BLIND OR ACCESS APPLICATIONS

Even when there is access to both sides, SOUTHCO Drive Rivets are specified because they make a one-man job of a two-man operation. They are so simple that costs are reduced through faster riveting.

For the full story on SOUTHCO Drive Rivets, write to Southco Division, South Chester Corporation, 1406 Finance Bldg., Philadelphia 2, Penna.

SOUTHCO®
FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

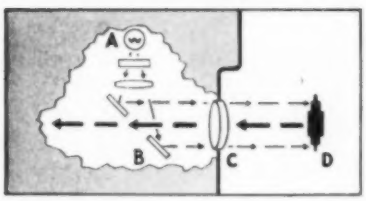
©1953
Pat. No. 2640618
Other Pats. Pend.
Rivet and Mfg.

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

Plain Pointers on Projection

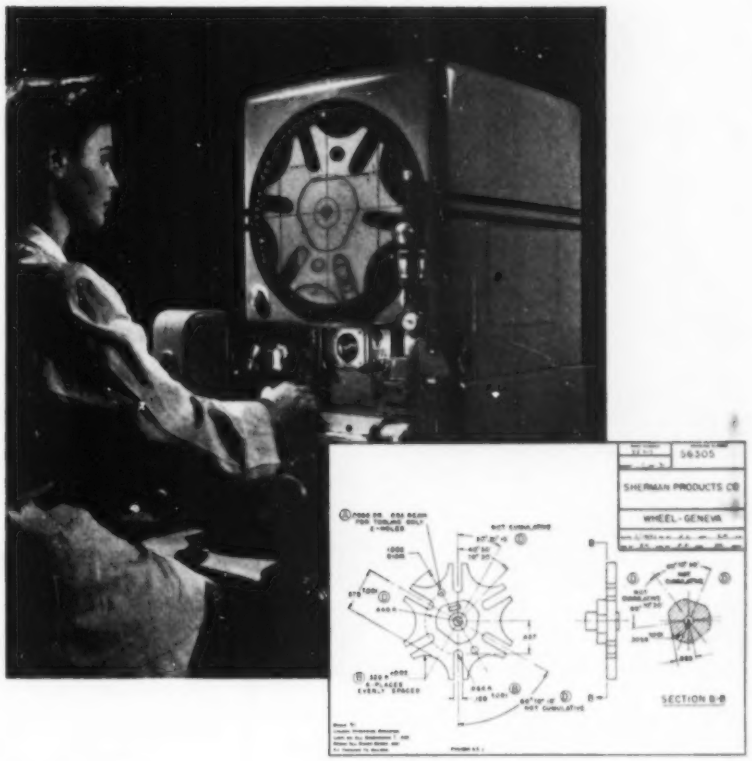
ONE of the basic precepts of the study of geometrical optics is that the angle of incidence equals the angle of reflection. This law, recognized by the Greek philosophers and refined by later investigators, has an important bearing on modern optical gaging by projection. In numerous instances it is desirable to project the surface of a part on the screen to check the position and size of recesses or to measure features which may not permit conventional profile shadow images. The ease and success with which this is done depend not so much on how much light is thrown on the part as on how much of this light is reflected back into the instrument's lens.

Traditionally, surface illuminators used with contour projectors have been placed at an angle on each side of the lens or optical axis. This was true of the pilot model of the Kodak Contour Projector and we frankly admit it proved somewhat less than perfect. Since the light struck the part at an acute angle, it was reflected from the surface at a similar angle—reflected away from the lens, as it were, when the part was normal to the lens for a distortion-free image.



However, between design of this pilot model and our production models, our optical engineers devised a radically different system. As shown here schematically, this consists of a 1000-watt lamp (A) so mounted that its light is reflected by a mirror (B) through the front lens (C) of the instrument. Since the light from this surface illuminator travels along the axis of the lens, it is reflected from a part (D) back through the lens with negligible loss. By staging the part to be measured perpendicular to the optical axis, the angles of incidence and reflection approach zero degrees. Light is reflected from the part back on its own path.

This permits inspection of deep recesses and results in a screen image of unusual brilliance when projecting surfaces. The latter we have frequently demonstrated by placing the works of a small watch on our contour projector. Spectators are generally impressed to see the wheels and gears in motion, and on at least one occasion we've had a watch brought to us for repair. While this was perhaps somewhat embarassing, we're reconciled by the thought that users of our projectors are saved embarrassment daily because of the accuracy with which they can gage parts to "tenths."



Inspection costs fall when surface features and profiles are checked simultaneously

YOU may be missing a chance to lower inspection costs, speed the work, if you're overlooking the surface illumination feature of the Kodak Contour Projector.

Take the Geneva wheel shown here. By optical gaging, 47 dimensions are checked to tolerances of .001" in *less than 60 seconds,* using a single chart-gage and a simple staging fixture. Conventional shadow projection is used to check 36 of these. But only through surface projection can the 11 dimensions of the hub, including five angles and three radii, be checked simultaneously. A flick of a switch and the unique, self-contained surface illuminator (described in the column at the left) makes checking surface details as easy as measuring shadow profile.

The inherent speed and accuracy of inspection and measurement on Kodak Contour Projectors are lowering inspection costs on all sorts of parts, simple and complex, large and small. The field representative in your area will be glad to show you how optical gaging can work for you. To get in touch with him, or for a copy of a booklet, "Kodak Contour Projector," write to:

Special Products Sales Division
EASTMAN KODAK COMPANY
Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Optical Gaging

A new sound movie, Optical Gaging, shows how to simplify complex inspection problems. We'll tell you how to get it for a showing.

Kodak
TRADE-MARK

Could you duplicate these OK hardened ways?

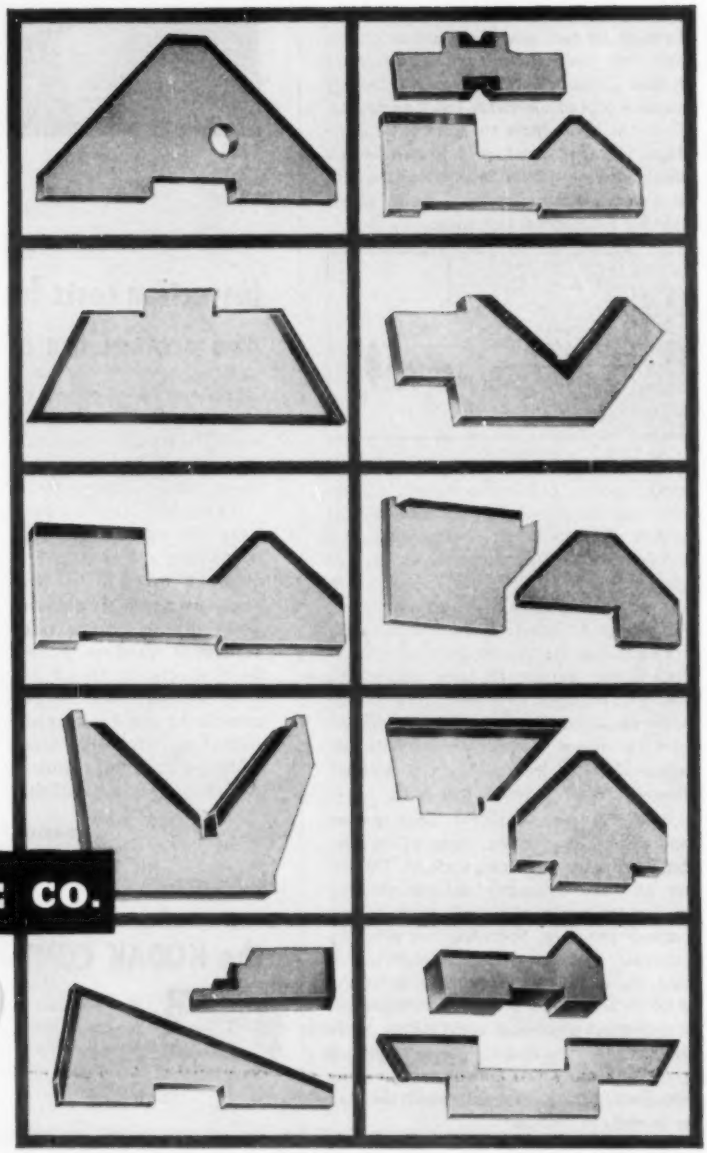
Here are only a few of the wide variety of shapes made possible by OK 3-point advantage:

1. LAMINATED CONSTRUCTION Through Ohio Knife's own process, long-wearing tool steel is welded to a soft steel backing under 2500 tons pressure. This process enables us to deliver ways answering any requirement for hardness, regardless of the shape of the way.

2. SPECIAL HEAT-TREATMENT OK ways' extreme hardness (65-66 Rockwell "C") to a uniform depth is a key factor in successful performance regardless of shape.

3. PRECISION EQUIPMENT Ohio Knife has the extensive plant facilities and equipment required for supreme accuracy. OK hardened ways and gibs are ground to tolerances of ± .0002.

Besides a wide range of standard sizes and shapes, OK ways are made to your specifications.



Write for comprehensive Bulletin to Dept. B.

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

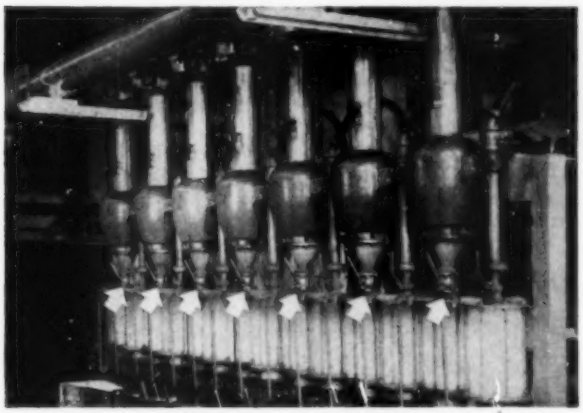
Manufacturers for the Metal Working Industry of:

SLITTER KNIVES • SHEAR BLADES • BRONZE WAYS
ROTARY SHEAR KNIVES • HARDENED SPACERS
HARDENED WAYS • BALL RACES
WEAR STRIPS • GIBS

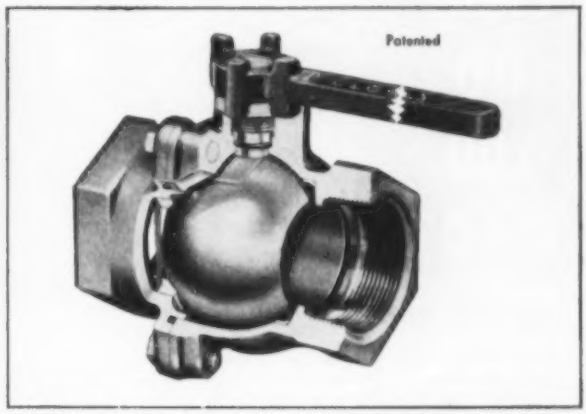
Do you need a FULL-FLOW VALVE?

Full-Flow in Fishing Boats, where salt water, fish scales, wood splinters, dirt, etc., complicate bilge-pumping. Rockwood Ball Valves "out-wear and out-perform all other makes," says a maker of marine pumping equipment.

Full-Flow in a Ceramics Plant, where turbulence in conventional valves admits air bubbles to the clay-and-water mixture, causing "pinholes" in products. The full round opening of Rockwood Ball Valves prevents turbulence, protects products.



Full-Flow in Paper-Making, where dirt in pulp liquids endangers product quality. By reducing friction caused by impurities in the flow, Rockwood Ball Valves in dirt-removing units perform better, last longer.



Full-Flow for Many Advantages, in widely differing applications. The elimination of turbulence in Rockwood Ball Valves is just one of its benefits that pay off in more trouble-free, more profitable pumping.

Plus these other exclusive features

Leakproof — in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

Quick Opening and Closing — needs only ¼ turn even under full pressure.

Resists Wear Longer — Chrome-plated bronze ball stands up under abrasion, pitting and scratching.

From alcohol to asphalt, from petroleum to pickling acids, Rockwood Ball Valves perform with trouble-free continuity. Longer time between replacements, less maintenance on the job. Comes in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. The coupon will bring you complete information.

ROCKWOOD

THE FLOW IS AS ROUND AS THE PIPE ITSELF

FULL-FLOW BALL VALVES

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
106 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....

Title.....

Company.....

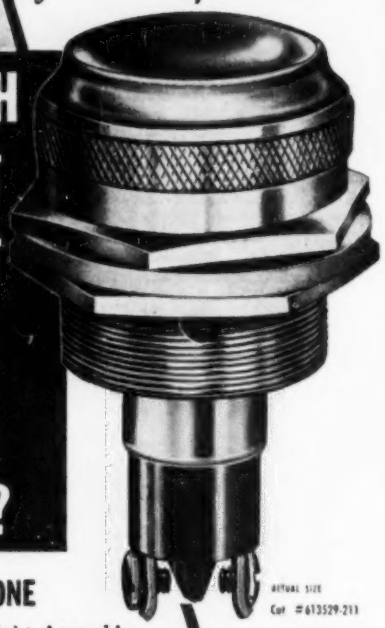
City.....

Zone.....State.....

DIALCO

for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?



THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

ACTUAL SIZE
Cat #613529-213

or

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

ACTUAL SIZE
Cat #8-1930-621

Dialco HAS THE COMPLETE LINE of INDICATOR and PANEL LIGHTS

Samples to suit your own special conditions and requirements will be sent promptly and **without cost**. Just outline your needs. Let our engineering department assist in selecting the **right lamp** and the **best pilot light** for YOU.

Write for the Dialco HANDBOOK of PILOT LIGHTS

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVENUE, BROOKLYN 37, N. Y. HYACINTH 7-7600

CLUTCHES by ROCKFORD

Lifts, Carries and Places Any Size; Shape or Weight

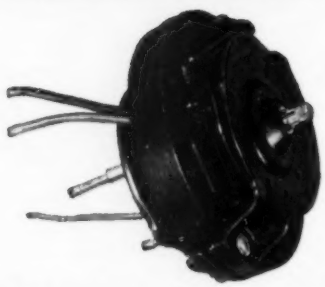
KRANE CAR, built by Silent Hoist & Crane Company, picks up a load of any shape or size, up to ten tons, transports it and spots it accurately, smoothly and safely. ROCKFORD CLUTCHES control the power transmission from its one-man-operated single engine. Let ROCKFORD clutch engineers help with *your* power control problems.

B-W ENGINEERING MAKES IT WORK
B-W PRODUCTION MAKES IT AVAILABLE

ENGINEERING BULLETIN SENT ON REQUEST

ROCKFORD CLUTCH DIVISION BORG-WARNER
209 Catherine Street, Rockford, Illinois, U. S. A.

HEINZE MOTORS



New Capacitor Motor AM-100

Originally developed for TV antenna rotator service. Reversible. Excellent also for laboratory or experimental use: or for advertising displays, etc.

1/100 hp. 2-pole. Operates at free speed of 3300 rpm or load speed of 3100 rpm.

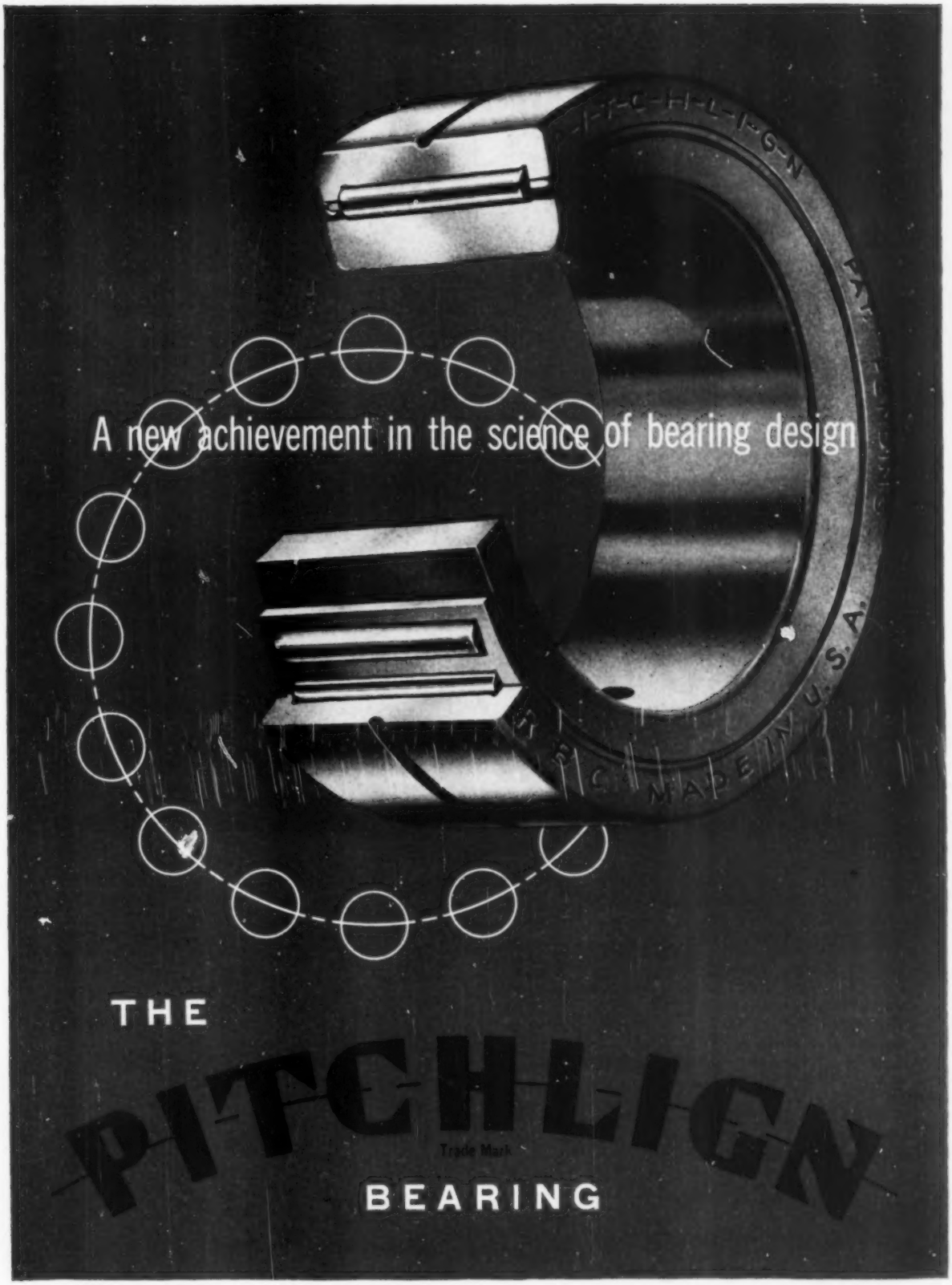
40 watts. 24 volts. 60 cycles, AC.

Skeleton frame, but can be supplied in ventilated case, same size and appearance as Heinze Type Z motor.

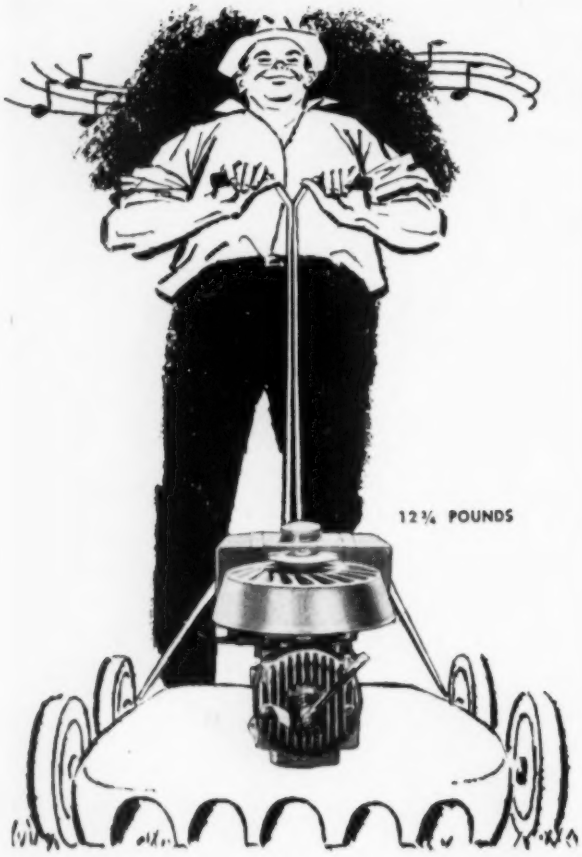
Mountings available.

The Heinze catalog shows this and other Heinze sub-fractional horsepower motors and blowers.

Heinze Electric Co
685 Lawrence Street, LOWELL, MASS



Write for Bulletin SF-669 Roller Bearing Company of America, Sullivan Way, West Trenton, New Jersey



Humming at 100 or 500 hours

For Long Life it's the POWER PRODUCTS *Lightweight*

Hundreds of thousands of happy users have proved by years of use that the POWER PRODUCTS 2-cycle engine is built for long life.

The reason, of course, is that Power Products has added extra features that assure long-life and trouble-free performance

- LIGHTWEIGHT
- MINIMUM EFFORT STARTING
- LONG LIFE, LESS MAINTENANCE
- FULL CARBURETION
- BALL BEARING MAIN BEARINGS
- SEALED DRIP PROOF CRANKCASE
- FULLY ENCLOSED, FLY-BALL GOVERNOR
- NO OIL CHANGING OR CHECKING
- CLOG FREE COOLING SYSTEM

These small extras make a big difference in performance . . . keep customers happy . . . make it pay to choose the *Lightweight*

be modern-go *Lightweight*

POWER PRODUCTS CORPORATION

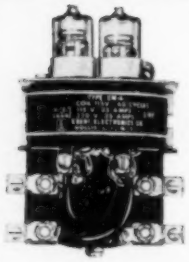
GRAFTON, WISCONSIN

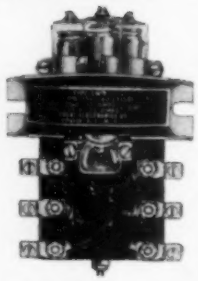
Mercury Plunger Relays

FOR

2 and 3 POLE APPLICATIONS

- Hermetically Sealed
- Silent Operation
- Explosion Proof
- No Maintenance
- Mercury–Mercury Contact





The many advantages of mercury plunger construction are now available in relays for 2 and 3 pole applications.

Compact size and high current handling capacity (up to 60 amps) permits realistic savings in cost and space. For complete details just ask for our free catalogue—and don't forget—our engineering division is ready to serve on any of your relay problems.

EBERT ELECTRONICS CO.

212-26 N Jamaica Ave., Queens Village 28, L. I., N. Y.

IF IT'S MADE FROM FLAT or ROUND STEEL CUYAHOGA CAN MAKE IT!

FLAT SPRINGS
STAMPINGS
SNAP-CLIPS

Produced in any quantity... large production runs a specialty

SPRINGS and WIRE FORMS

•

Every Type
Any Style

Custombuilt to fit your need

The CUYAHOGA SPRING Co.

SUBSIDIARY OF THE BARIUM STEEL CORP

10254 BEREA ROAD • CLEVELAND 2, OHIO

Miller

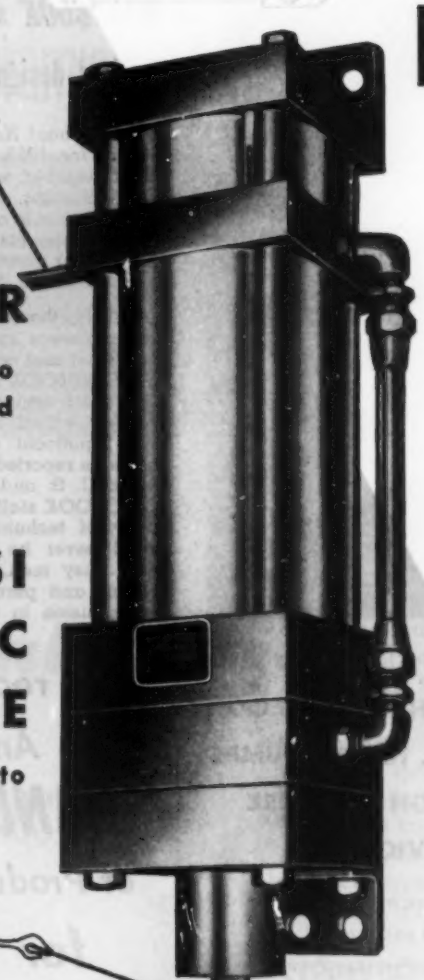
FLUID PRESSURE BOOSTERS

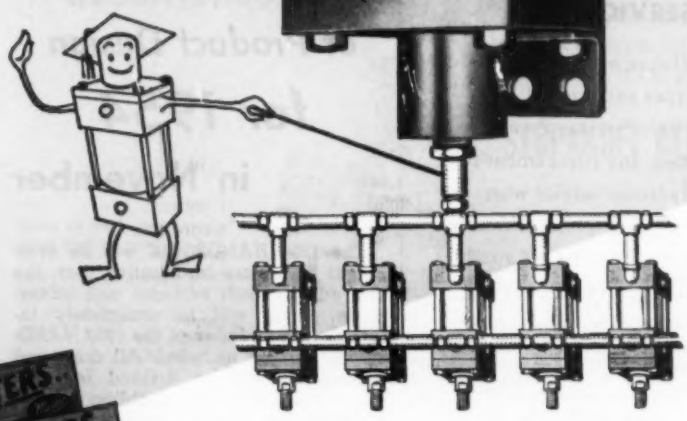
BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

Output Range: 200 to 10,000 psi Fluid





- Save space, weight and investment cost by replacing pump installations in many applications
- Less costly to install, operate and maintain
- **Hold pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide — at point of cylinder thrust — more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute

Visit Our
BOOTH #1217
October 1953
"METALS" SHOW!

ESPECIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER MOTOR COMPANY

2002-04 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

More Data for Designers

MODEL CK

Compact, self-priming, unidirectional. Spring-loaded packing. Direct drive or belted units. Capacities from 5 to 50 g.p.m. Pressures to 400 p.s.i.

MODELS 7CK-8CK

100 and 200 g.p.m. pumps with flanged ports at right angles. Pressures to 200 p.s.i.

MODEL CKB

Same as Model CK, sizes 2 to 6, with dependable Tuthill mechanical shaft seal.

MODEL RCK

Includes Tuthill's exclusive automatic reversing feature which permits driving pump in either direction without changing direction of flow or port positions. Available also with mechanical seal as Model RCKB.

GET THIS NEW TUTHILL CATALOG NO. 103 ON PUMPS FOR HIGH PRESSURE SERVICE

This new guide gives you types and sizes of Tuthill High Pressure Pumps to meet any requirement for hydraulic service where the operating pressure does not exceed 400 p.s.i. Capacities range from 5 to 200 g.p.m. The following models are typical.

Write for Tuthill Catalog No. 103 today.

TUTHILL PUMP COMPANY

Dependable Rotary Pumps since 1927

939 East 95th Street, Chicago 19, Illinois

TUTHILL PUMPS FOR THE PURPOSE

Canadian Affiliate:
Ingersoll Machine & Tool Company, Ltd.
Ingersoll, Ontario, Canada

What makes the *Annual HANDBOOK* so popular with product-design engineers?

The Annual HANDBOOK of Product Design for 1953, which you received last November, was the *first edition* of this continuing, yearly service to you. Your thousands of inquiries and enthusiastic comments have represented to us the best possible evidence of your enthusiasm for this new service.

Clearly, the *HANDBOOK* brings design-engineers everywhere information they want and need. Into each issue of the *HANDBOOK* go hundreds of pages of product engineering data, carefully selected, edited, and illustrated to give you significant engineering developments as reported during the year both in the U. S. and abroad. Our special *HANDBOOK* staff searches through an array of technical periodicals which could never be adequately read by most busy men, to acquire the most helpful and permanently useful data for inclusion in the *HANDBOOK*.

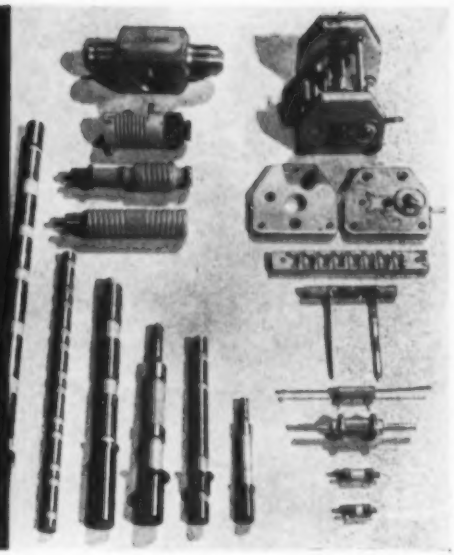
You'll receive your *Annual HANDBOOK of Product Design for 1954* in November

The *1954 HANDBOOK* will be *even bigger* and more informative than the first edition. Both editorial and advertising pages will be completely indexed, and an index of the *1953 HANDBOOK* will be included. All data and advertising will be divided into ten major classifications, enabling you to locate exactly the subject matter you want quickly.

Your *HANDBOOK for 1954* will be sent to you in Mid-November as part of your regular subscription to *Product Engineering*.

Product Engineering
330 West 42nd St.
New York 36, N. Y.

ceramics and metal



The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

Stupakoff

assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

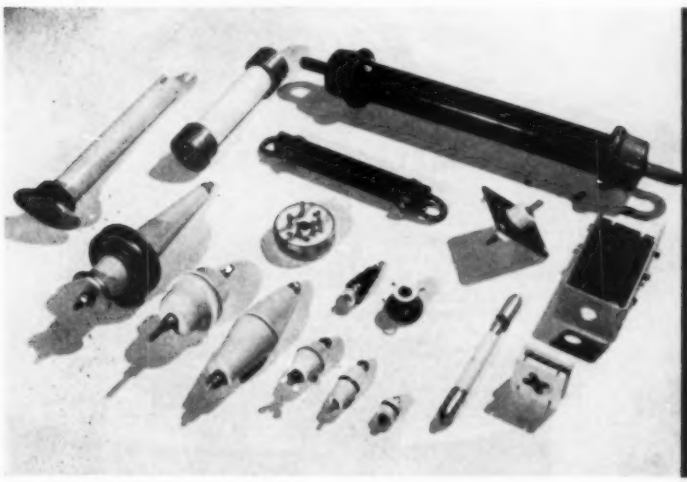
Among the assemblies made by Stupakoff are. rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

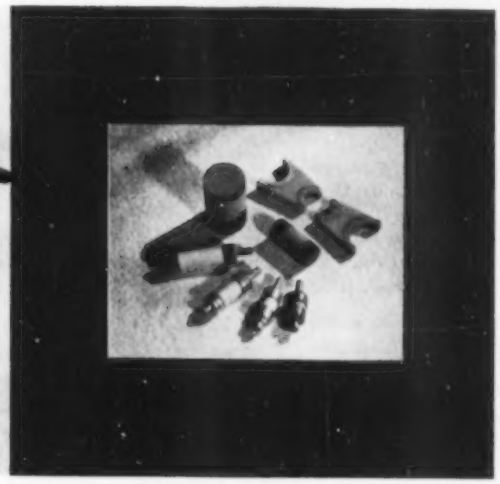
STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

Some of the larger types of Stupakoff metallized ceramic parts.

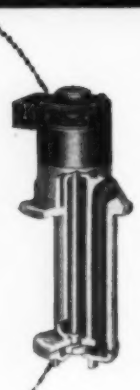


Small metallized ceramic parts are accurately made and dependably uniform.



to OEM

Designed and Built



for your Specific job

Brady Pumps

We welcome your pump problems and inquiries. The answer to your problem may be in the files of our Engineering Department. For three generations, Brady has specialized in the design and manufacture of small Centrifugal Pumps . . . used as original equipment by leading manufacturers in Air Conditioning, Refrigeration, Dairy, Machine Tool and many otner Industries.

Write, phone or wire

Brady CORPORATION

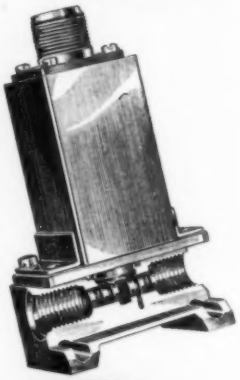
1005 East 18th Street Muncie, Indiana

NEW *VALCOR* PRINCIPLE IS SOLVING MORE SOLENOID VALVE PROBLEMS

*Valcor Floating Shear Seal: Simple design eliminates need for precision fits. Seals 100% in both directions . . . and seal improves with use because of self-lapping. Self-cleaning, cannot clog because of exclusive floating shear seal action.

• **Straight-Through Flow:** Absolute minimum pressure drop.

• **Sealed-in-Coil:** Never an electrical failure reported. Built to withstand shock, vibration, and the elements.



Send for free booklet— "The Valcor Solenoid Valve with the Floating Shear Seal."

Valcor Engineering Corp., Carnegie Ave., Kenilworth, N. J.

VALCOR Solenoid Valves

*Pat. Pending

METAL NAME PLATES

Grammes metal craftsmen will make your name plate stand out and make it "sell" as well as *tell*. They are experienced in giving you just what you want: Readability that endures in metal. A sketch or blueprint—or just a hint—is all we need to show you what we can do with a name plate for you. Send for our "Tips on Name Plate Selection and Design". Write to:

METAL STAMPINGS
NAME PLATES
DIALS

L. F. GRAMMES & SONS
INCORPORATED
ALLENTOWN, PA.

ADVERTISING SPECIALTIES
TRIMS • BEZELS
PANELS

SPECIALISTS IN DECORATIVE METAL

NOW
more sizes of...

Stainless Socket Cap and Set Screws

Available in stock from your Allen o Distributor

Demand for rust and corrosion resistant socket screws of high finish 18-8 stainless steel has been increasing steadily for ten years.

Allens have become the leading make because of the inherent advantages of Allen manufacturing methods, and because Allen Distributors carry the widest range of sizes as standard stock items – saving their customers time and money.

Now Allen widens its margin of leadership with still more distributor-stocked standard sizes in stainless:

97 Standard Sizes in Stainless Steel Socket Cap Screws

#4 x ¼" to ⅝" x 3" with NC threads
#10 x ⅜" to ⅜" x 1½" with NF threads

54 Standard Sizes in Stainless Steel Socket Set Screws

#4 x ⅛" to ½" x 1" with NC threads
#10 in lengths from 3/16" to ¾" with NF threads

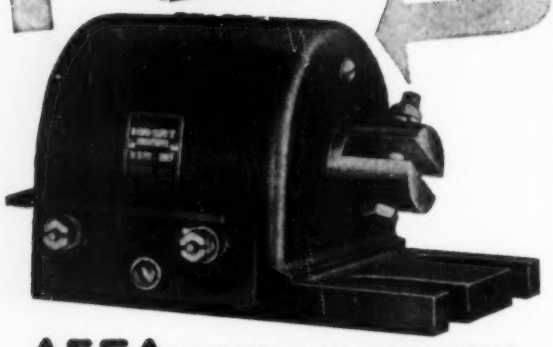
ALLEN
MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

NEW
Grip-head Stainless Steel cap screws for more convenient handling and easy, time-saving starting.

Sold only through leading industrial distributors

A NEW APPROACH ON

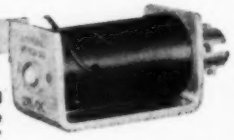
Solenoids



ASCO SELECTED AND ENGINEERED FOR YOUR APPLICATION TO INSURE TROUBLE-FREE PERFORMANCE

ASCO designs and manufactures an extensive line of AC and DC Solenoids for use with machine tools, conveyor systems, and all types of automatic machinery. If one of the many standard ASCO Solenoids will not serve you, our engineers will work out a special design for your requirements.

TYPICAL EXAMPLES:



ASCO DC Solenoid—a tapered core, tapered stub, pull type Solenoid. Dimensions: 4¼" long, 2" wide, $1\frac{29}{32}$" high. Available for any standard DC voltage. Pull strength ranges from 1¼ to 11 pounds.

ASCO AC Solenoid for 110 to 440 volts; 25, 50 or 60 cycles with pulls ranging from 18 to 28 ounces at ½" stroke to a maximum of 5 lbs. 4 oz. at 0 stroke. Overall size: 3" long, $1\frac{31}{32}$" wide, 2" high.

ASCO Electro-Magnetic CONTROLS

Solenoids are only part of the wide range of Electromagnetic Controls and Solenoid Valves manufactured by ASCO—Headquarters for Electromagnetic Controls.

Write for literature.

Automatic Switch Co.

385 LAKESIDE AVENUE · ORANGE, NEW JERSEY

RESINITE

gives you the HIGHEST RESISTIVITY of any RESINATED PRODUCT

Resinite Coil Forms are laboratory tested and field proven. Their operating characteristics . . . volume resistivity . . . power factor . . . thermal properties . . . low moisture absorption . . . and resistance to voltage breakdown—represent a new achievement in basic components for electronic application.

Resinite Coil Forms are available with inside or outside threads, slotted, punched or embossed. Axial pressure in excess of 25 lbs. is accomplished through a special three row threaded design. Torque can be controlled to + or −1 in. oz.

RESINITE *8104:* for coil forms requiring very high dielectric properties under extreme humidity.

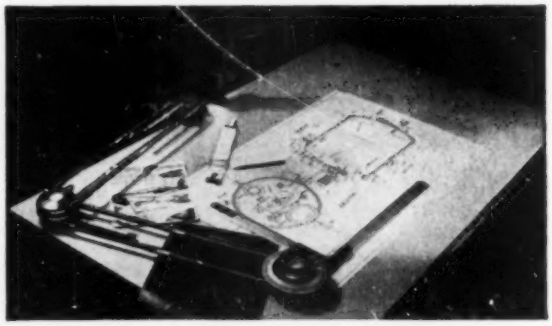
RESINITE *"AC":* for applications requiring very high dielectric strength. *Electrolytic corrosion is impossible.*

RESINITE *104:* for stapling, severe forming, fabricating.

Send today for full details and technical information.

RESINITE CORPORATION
DIVISION OF PRECISION PAPER TUBE

2035K W. Charleston St., Chicago 47, Ill.
79 Chapel St., Hartford, Conn.



Always Good . . . **NOW BETTER**

Universal Drafting Machine

WITH 360° FULL-VISION PROTRACTOR

The Universal policy of continuing product improvement has again borne fruit. Always good—always tops in its ability to produce precise lower-cost engineering drawings—the Universal now is better—a new base line clamp enhancing its accuracy and expediting pressure adjustment of the clamp whenever necessary.

Universal is a work-horse on any type board—flat, angle or vertical. It combines into one sturdy instrument all the most used tools of the draftsman's art. It saves time—effort—money. Used with accurate Duraline Scales, the Universal Drafting Machine will be a permanent challenge to better engineering performance on YOUR board.

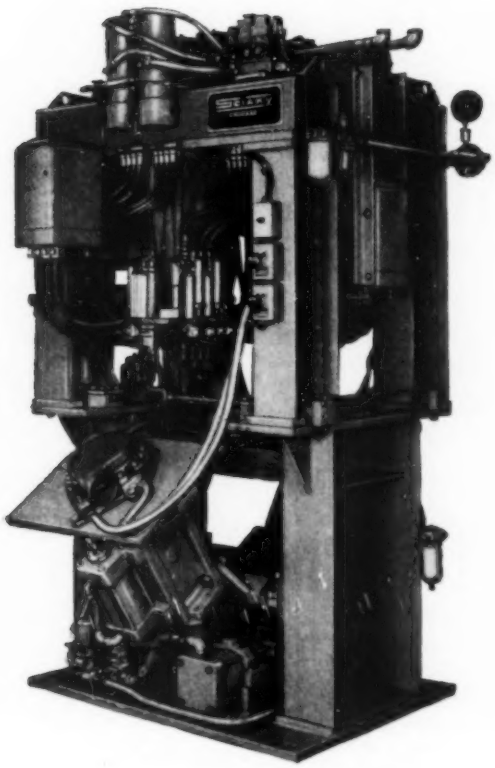
Write today for illustrated bulletins.

THE UNIVERSAL DRAFTING MACHINE CORP.

7960 Lorain Ave. • CLEVELAND 2, OHIO

UNIVERSAL
DRAFTING MACHINE — DURALINE SCALES

NEW
HIGH PRODUCTION WELDER
READILY ADAPTABLE TO
PRODUCTION CHANGES



The Sciaky Standard SX Electric Resistance Welder equipped as a 36 Gun Unit for welding blower housings at the rate of 500 per 50 minute hour.

New Sciaky Standard Multiple Gun Welder Designed for Wide Variety of Production Applications

High production, multiple gun applications no longer require uneconomical C-frame type electric resistance welding machines with special tooling, or complex, specially designed, one-job machines.

Now, Sciaky, pioneers and inventors of electric resistance welding machines, offers a standard multiple gun welder that can be readily adapted for production changes within the capacity of the machine.

The Sciaky SX Welder, a dual platen unit, mounts simple superstructure providing for different arrangements of standard transformer, booster, and welding electrode units.

With approved J. I. C. controls, and featuring either independent or simultaneous dual platen operation, the Sciaky SX Welder offers all the advantages of high production, precision welding, *plus* the tremendous economies of adaptability to production changes.

For complete information, write for Bulletin 313-12.

Preview new Sciaky welders at Booth 2106 National Metals Show, Cleveland, Oct. 19-23.

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY

Plants: Chicago • London • Paris Sales Offices: Chicago, Ill. • Buffalo, N. Y. • Cleveland, Ohio • Dayton, Ohio • Detroit, Mich. • Ft. Worth, Texas • Hollywood, Calif. • New York, N.Y. • Philadelphia, Pa. • Washington, D.C.

YOU NAME IT-

FELT

by FELTERS

will do it...

Filters
Auto parts
Washers
Noise dampeners
Wicks
Packings
Liners
Electrical appliances
Aircraft parts
Shock absorbers
Vibration controls

(Your product goes here)

Resiliency that permits constant spring-back to original shape . . . and good absorptive characteristics . . . are just two of the many properties you can get in Felt made by Felters.

If you have a problem that could be solved by a soft, porous material, or by a hard, dense material — your answer could well be a Felt made by Felters.

The "Felters Design Book" describes several usual and unusual uses for Felt. Drop us a line and we will send you a copy.

HEARD ABOUT **UNISORB®** *— THE MODERN MACHINERY MOUNTING?*

The **FELTERS** Company
910 South Street, Boston 11, Mass.

STRAIN GAGE TRANS-DUCERS

For Measurement and Control

This 28-page Special Editorial Report from our November 1952 issue will give you the most up-to-date details on strain gages and this design tool's great versatility.

The first of five sections in this special report covers the two classes of gage—bonded and unbonded, types of bridge circuit, amplifying and recording equipment and the systems combining these components. The four remaining sections take up the different types of transducers designed specifically for measuring pressure, flow, weight and displacement. Case histories follow each transducer section to illustrate some of the more unusual applications for strain gage transducers.

Copies available at 35 cents each.

READER SERVICE DEPARTMENT

Product Engineering

McGraw-Hill Building
New York 36, N. Y.

Here's one you'll want to bite on! It's Formbrite

Upper lure is Formbrite. Lower one is made of ANACONDA Fancy Pattern Embossed Brass.

FISH find this particular line of brass spinners so attractive that fishermen's demands have built annual sales of the Aeroplane Tackle Manufacturing Company of Denver to more than two million lures of all types.

The high finish on the spinner is part of the secret. While the cost of producing this is of no interest to the fish, it is to the manufacturer. Recently all brass orders were changed to Formbrite*, the superior ANACONDA Drawing Brass that has enabled this firm to cut polishing costs over 25%, and on several stamped products to produce the required finish by tumbling only prior to lacquering or plating.

Formbrite, with its superfine grain, provides a surface far superior to ordinary drawing brass. It is stronger, harder, more scratch-resistant than ordinary brass, yet retains remarkable ductility for forming and drawing. It's a premium product at a non-premium price. If these features lure you, we should like to show you how this better brass can cut your product's finishing costs. Or write for Publication B-39 to *The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.*

Thirty-five years ago a fisherman, disgusted with his luck, cut up an old brass bait box to make himself a spinner resembling an old-time airplane propeller. Both fish and fisherman liked it so much, he started what is now a big and thriving business.

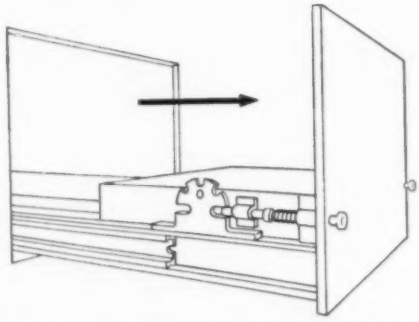
*Reg. U.S. Pat. Off. 5992

Formbrite

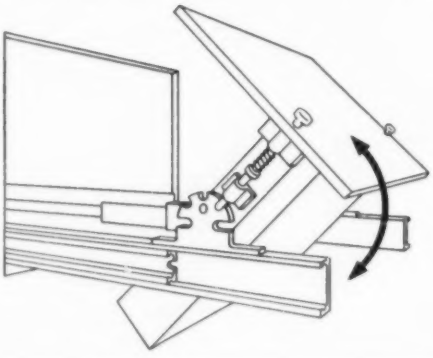
DRAWING BRASS

An ANACONDA® product made by The American Brass Company

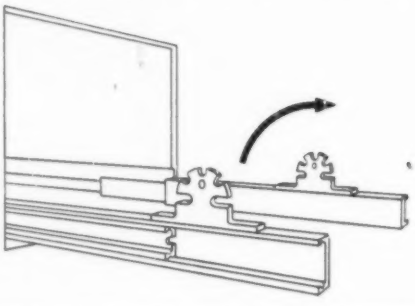
slides to **full** extension



tilts, locks securely



completely **removable**



grant industrial slides

Does this kind of action suggest applications in your field? If your design problem requires sliding motion (up to 500 lbs. load) plus tilting (+90° or −90°, and any intermediate angles) plus positive locking—or any one of these—you will do well to consult "the foremost name in sliding devices." Write to Grant Pulley & Hardware Company, 31-77 Whitestone Parkway, Flushing, New York.

NOW...A NEW LUBRICANT

For Heavy Loads, High Torques, Difficult Maintenance

TRADE **TORX** MARK

Pat. applied for

Silver Alloy Based Lubricant

Protects Expensive Bearings, Gears, and other Moving Parts by a coating of low-friction, corrosive resistant, tough

SILVER ALLOY

right where you need it, when you need it. "Plates out" on bearing surfaces under heavy loads.

Though higher in first cost it is

MORE ECONOMICAL—because you use less

SAFER—because it protects expensive parts

BETTER—because it helps prevent costly breakdowns and replacements

Send for literature and free samples—on your letterhead to

UNITED INTERNATIONAL RESEARCH, Inc.
Manufacturing Division
10-15 43rd Avenue, Long Island City, N. Y.

★ **CHAPMAN**

ELECTRIC NEUTRALIZER CO.
PORTLAND 6, MAINE

Mid-West Representative:
D. H. SPEIDEL, 343 So. Dearborn St., Chicago

Eliminators of Static Wherever It Develops in Manufacturing Processes

Inquiries Are Invited

Specialists in the Elimination of . . .

STATIC

SAFELY · INSTANTLY

Facts about

Product Engineering

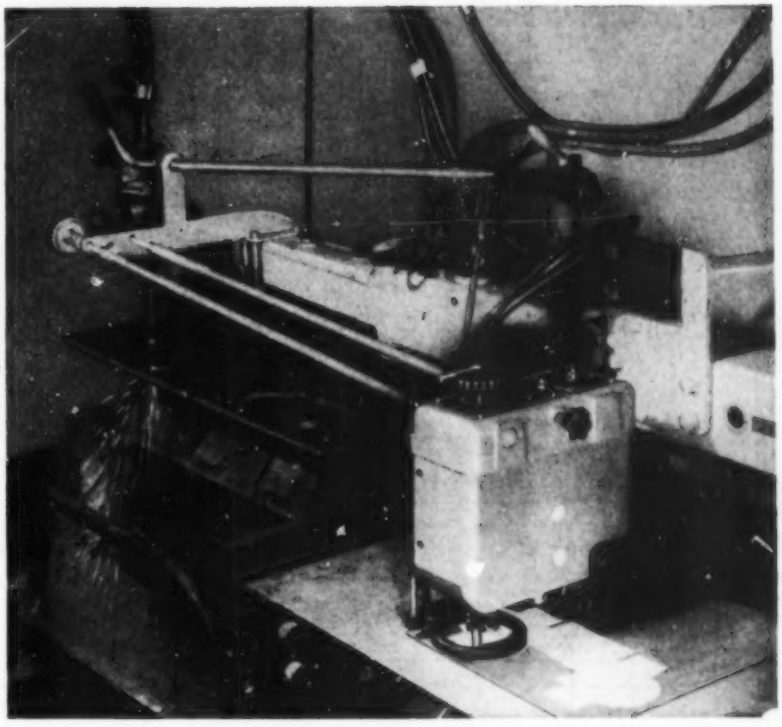
Product Engineering **is the only paid-circulation magazine serving design engineers.**

SIMPLIFY Your Shape-Cutting Jobs with the . . .

OXWELD Automatic Tracer

Trade-Mark

- Positive templet contact . . . electronic steering control . . . maximum tracing accuracy
- Templets are easy to make, low-cost
- No kerf allowance required in templet
- Intricate shapes easily reproduced
- Dynamic braking prevents overruns
- Local or remote controls . . . simple to operate



With an OXWELD Automatic Tracer to guide your oxygen-cutting machine, you need never forego the advantages of templet tracing because of time or cost. Whatever the shape—whether you need one piece or many—templet requirements are simple. Just draw your templet, full size, on a thin sheet of inexpensive plastic. Then cut it out with scissors or knife. It's that quick and easy. There's no tedious forming. To compensate for kerf width, just set a handy dial on the Tracer.

The OXWELD Automatic Tracer follows practically any templet shape within extremely close tolerances. It can also be used to hand trace directly from blueprints or drawings. Drive action is smooth and steady with both single- and multiple-blowpipe setups.

Your nearest LINDE representative will be glad to help you plan an OXWELD Automatic Tracer installation to fit either your present shape-cutting machine or one of the available OXWELD Shape-Cutting Machines.

WRITE TODAY FOR FREE BOOKLET F-8086

Linde

TRADE-MARK

LINDE AIR PRODUCTS COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The terms "Linde" and "Oxweld" are registered trade-marks of Union Carbide and Carbon Corporation.

Automatic Valve Operation With No Electrical Power!

NEW! ASCO®

Pressure Operated Manual Reset Valves

Reduce Hazards!
Provide Reliable Operation!

APPLICATIONS—Bulletin 8035 Valves are ideal for remotely controlled, safety shut-off applications where it is not desirable to depend upon electrical power for operation. Valves are *pressure operated*, thus:

A. eliminating explosive hazards encountered with electrical operation.

B. assuring completely reliable operation where electricity is undependable or non-existing.

AVAILABILITY—Two types:

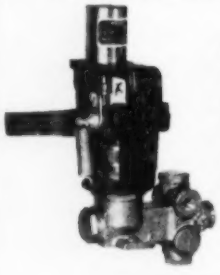
(1) Trip on pressure failure

(2) Trip on pressure application.

Standard Valves are constructed of bronze, cast-iron, steel, and stainless steel. Other materials are available if required. Valves can be provided with auxiliary switches for indicating lights or electrical control circuits.

MOVEMENT	PIPE SIZES (Inches)	Maximum PRESSURES (lbs./sq. in.)
2 Way*	⅜-6	600
3 Way	¼-½	300
4 Way	¼-¾	250

*Normally open or normally closed



OPERATION — Valve is manually set and remains in operating position until pressure is lost or applied (depending upon Valve type). Once tripped, the Valve must be manually reset.

ASCO Solenoid VALVES

ASCO Electro-Magnetic CONTROLS

ASCO lists hundreds of standard valve types and maintains an engineering service for special designs. We manufacture a complete line of Electromagnetic Controls, including Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Complete Control Panels.

Write for Free Literature!

Automatic Switch Co.

385 LAKESIDE AVENUE ORANGE NEW JERSEY

Making Better STAMPED Gears Is a Highly Developed Winzeler Specialty

Now, you can get *extreme accuracy* in the *Stamped* Gears you need. Better men and methods and machinery, developed through years of specialization, have resulted in a degree of economy and precision unequalled in the history of *Stamped Gear* making! Eliminate assembly headaches . . get smoother, quieter performance with WINZELER Stamped Gears.

WRITE FOR FREE *4-page catalog-folder describing our facilities and the various Stamped Gears, Tools and Assemblies we make. Valuable gear data and tables are included. Or, get ideas, samples and low cost estimates. No obligation.*

WINZELER Stamped Gears

WINZELER MANUFACTURING & TOOL CO.

1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD

Earl E. Morton, Chief of Aerodynamics. Has had many years of experience in aircraft manufacturing and was responsible for engineering on many now famous aircraft.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

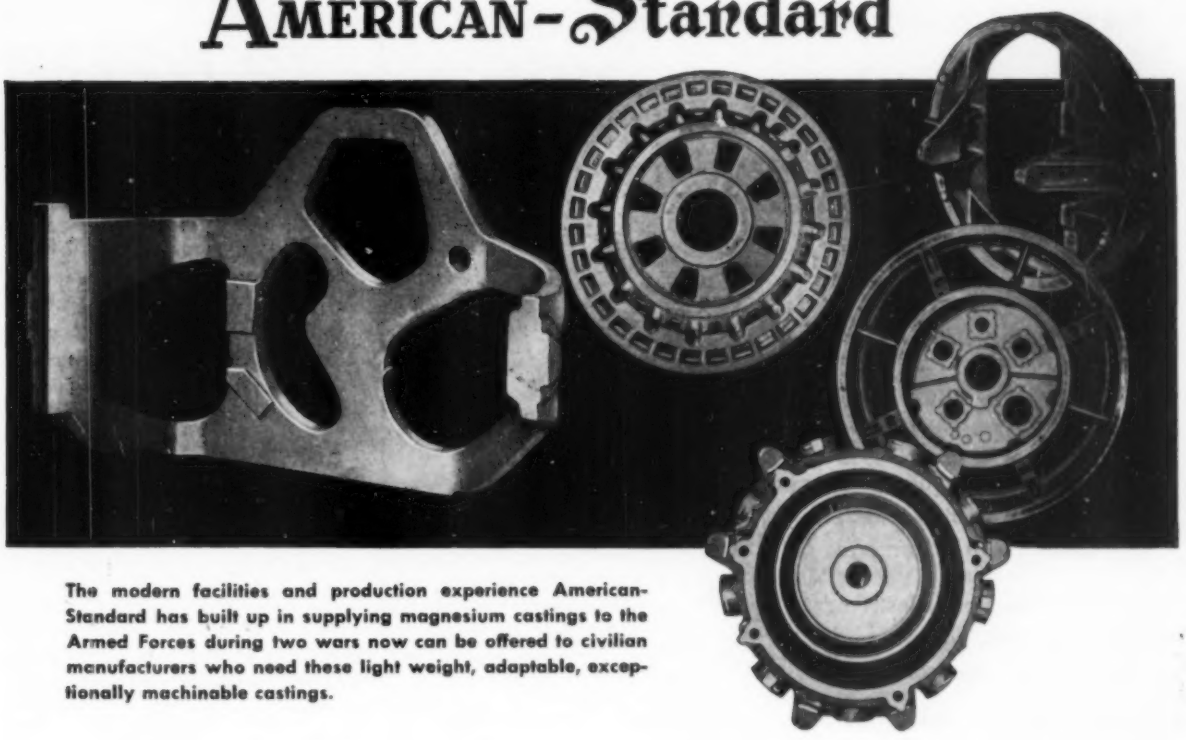
ENGINE AND AIRPLANE CORPORATION

FAIRCHILD *Aircraft Division*

HAGERSTOWN, MARYLAND

NOW...A new source of supply for Magnesium Sand Molded Castings!

AMERICAN-Standard



The modern facilities and production experience American-Standard has built up in supplying magnesium castings to the Armed Forces during two wars now can be offered to civilian manufacturers who need these light weight, adaptable, exceptionally machinable castings.

Although American-Standard is not primarily known for manufacturing magnesium castings, it is not a novice in this field. During World War II and since, American-Standard has turned out these light weight, durable castings for military use. In fact, during the last war when American-Standard had four plants producing these castings, it was the *largest* producer of magnesium sand molded castings.

Now American-Standard can offer to civilian manufacturers some of the output of its Litchfield, Illinois foundry . . . which is equipped with such facilities for control of casting as X-ray, spectrographic analysis, metallographic investigation and other recognized types of foundry controls.

It is equipped to turn out almost any size and shape of magnesium sand molded casting . . . and to serve you promptly.

American-Standard also has experienced engineers who will be glad to analyze your particular design problem, and to help you in any way possible. They're always at your call. For further information about Magnesium Sand Molded Castings, just return the coupon.

AMERICAN-Standard

American-Standard
Dpt. PE-103 Pittsburgh 30, Pa.
Please send free literature on Magnesium Sand Molded Castings.
Name .....
Company .....
Address .....
City ..... State .....

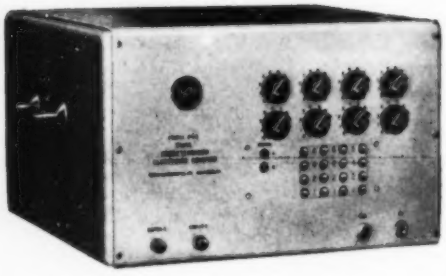
American Radiator & Standard Sanitary Corporation, Dpt. PE-103, Pittsburgh 30, Pa.

Serving home and industry

AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

Is Machine Process Control Your Problem ?

ANYTHING YOU CAN COUNT–YOU CAN CONTROL



SIMPLY
·
ECONOMICALLY
·
AUTOMATICALLY
·
DEPENDABLY
WITH A
Potter

POTTER PREDETERMINED COUNTER

For quantity, volume, lineal measurement, shaft revolution, or weight at speeds as high as 60,000 units a minute, check these advantages of electronic machine control.

POSITIVE — Potter Instruments have the "complement" design which presets, counts, and controls *all in one circuit*. It uses fewer tubes and components, and it's fail-safe in operation.

AUTOMATIC — Reset and recycling are completely automatic. Count can be repeated indefinitely or changed at will.

MULTIPLE SEQUENCE — Control of high speed machinery is simplified. Two or more sequential predetermined counts provide precise steps for complex machine operation.

ACCURATE — Count one or count a million, the Potter Predetermined Counter counts exactly.

SIMPLE — Simple to operate and maintain because it is built to operate in factory installations.

GET ALL THE IMPORTANT FACTS NOW

Let Potter experts show you how easily you can apply electronic counter techniques to control mechanical processes. A complete line of detectors is available for every kind of count problem. We'll be glad to suggest a unit or a system. For further information, write Dept. 10L.

POTTER INSTRUMENT CO., INC.
115 CUTTER MILL ROAD . GREAT NECK, N. Y.

The Annual

HANDBOOK

of Product Design

for 1954

is in production

The Annual HANDBOOK of Product Design for 1954 **will be ready in Mid-November. Our special *HANDBOOK* editorial staff, with the full cooperation of all other *Product Engineering* editors, is hard at work on the year-long job of selecting the most significant design-engineering data that is being published in the world's technical press this year.**

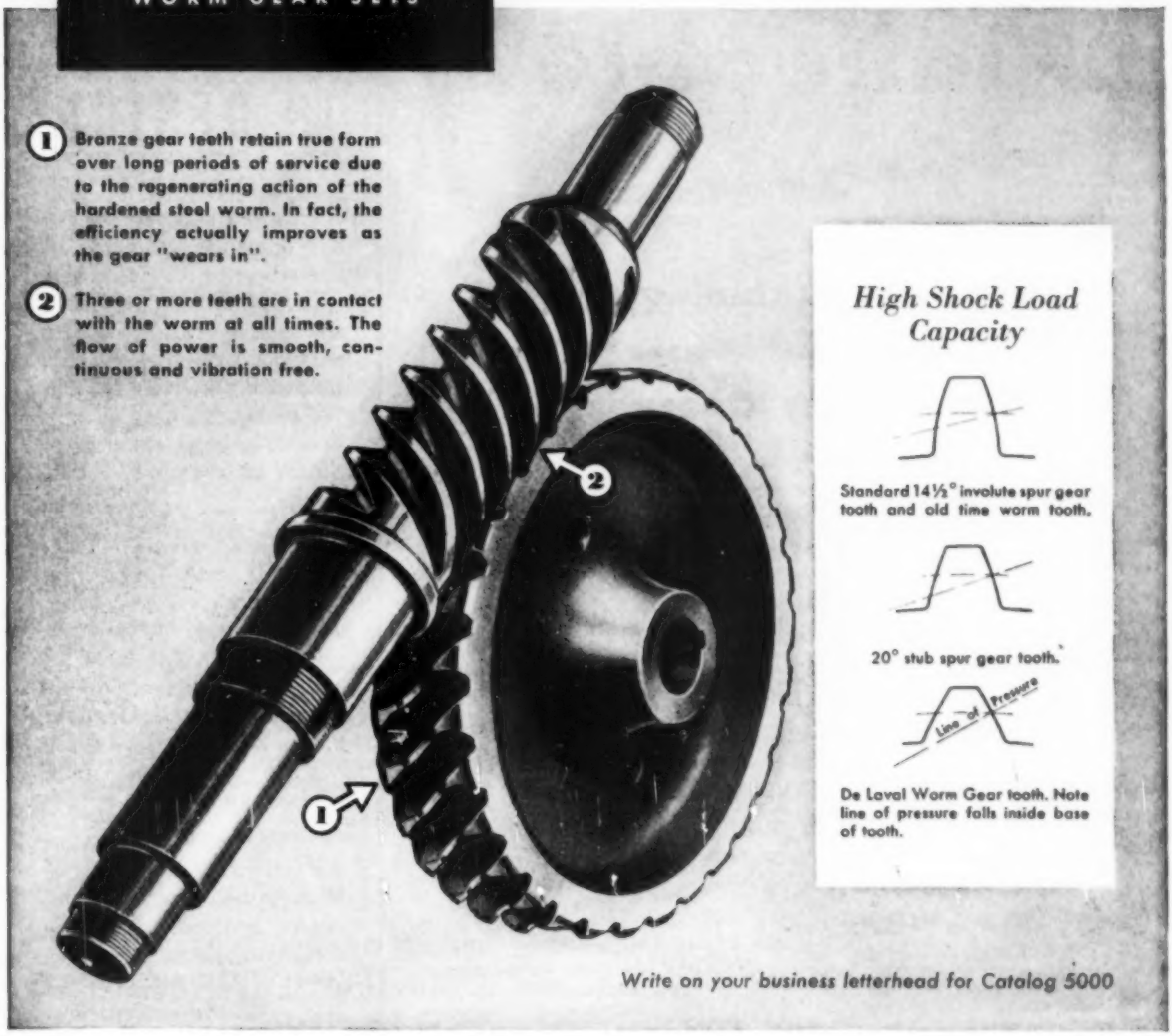
Indications are that this year's edition of the *HANDBOOK* will be even bigger and more helpful to you than the *1953 HANDBOOK* about which we are receiving so many enthusiastic comments from product-design engineers everywhere.

As before, all editorial material, and related advertisements, will be grouped into ten separate sections, enabling you to locate the information you want on any specific subject quickly. Both the editorial and advertising pages will be thoroughly indexed and, in addition, the 1954 edition will carry a complete editorial index of the *1953 HANDBOOK*.

Again this year, the *HANDBOOK* will come to you as part of your regular subscription to *Product Engineering*.

Product Engineering
330 West 42nd St.
New York 36, N. Y.

DE LAVAL WORM GEAR SETS *can take "hard knocks"*


1 Bronze gear teeth retain true form over long periods of service due to the regenerating action of the hardened steel worm. In fact, the efficiency actually improves as the gear "wears in".
2 Three or more teeth are in contact with the worm at all times. The flow of power is smooth, continuous and vibration free.
1
2
High Shock Load Capacity
Standard 14½° involute spur gear tooth and old time worm tooth.
20° stub spur gear tooth.
Line of Pressure
De Laval Worm Gear tooth. Note line of pressure falls inside base of tooth.
Write on your business letterhead for Catalog 5000

De Laval worm gear sets are designed to take punishment year-in, year-out. Gear teeth are under a crushing, instead of a bending load. Thus they withstand extremely high momentary and shock loads damaging to other forms of gearing. They need little attention even under the most rugged operating conditions.

De Laval manufactures these heavy-duty sets in a wide range of ratios from 3:1 to 100:1, with ratings of .1 hp to 550 hp and center distances from 3″ to 36″. It pays to design around these De Laval stock sizes. Special sets, however, can be furnished to any detailed specifications.

Proven applications of De Laval worm gear sets include the machine tool industry, rolling mills, process machinery, cranes and hoisting equipment and many similar uses.

DE LAVAL *Worm Gear Sets*

DE LAVAL STEAM TURBINE COMPANY
801 Nottingham Way, Trenton 2, New Jersey

...How about Malleable?

Save . . . Machining Costs
Material Waste
Unnecessary Operations

Excellent machinability, ductility and toughness, versatile castability, and high resistance to corrosion make malleable iron the most economical and useful material available to manufacturers today.

If you are not using malleable iron's remarkable properties it will pay you to call a malleable foundry and go over your products with their engineers. Skilled in casting design, they will show you how to save money and improve your products with Malleable Iron Castings.

This hydraulic press valve was formerly made as a steel forging. Changing to a malleable iron casting with all holes cored, drilling and counter boring were eliminated resulting in a saving of 80% in machining costs and 25% in weight.

Send for "Malleable Iron Facts", useful information on malleable iron properties and uses. Just write to Malleable Founders Society, Union Commerce Building, Cleveland 14, Ohio.

Malleable FOUNDERS' SOCIETY

1800 Union Commerce Building **Cleveland 14, Ohio**

High Speed

PHOTOGRAPHY IN DESIGN

High-speed photography not only offers the designer all of the advantages generally associated with ordinary stills and moving pictures, but also puts at his disposal a means for actually studying motions and events that until recently have never been "stopped" or slowed down to perceptible speeds.

Product Engineering's Special Editorial report on this subject gives designers a thorough study of basic considerations in the field of high-speed photography, operation and characteristics of major types of high-speed cameras, and some typical fields of application.

Included with this report is a fully illustrated Chart of High-Speed Camera Systems, headed by a master diagram that shows the essential elements of high-speed camera optical systems.

Reprints (including chart) available at 35¢ per copy

Reader Service Department

Product Engineering

McGraw-Hill Building.
New York 36, N. Y.

Facts about *HELI-COIL* inserts you should know

What they are

Heli-Coil* screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

What they are for

AS ORIGINAL COMPONENTS: *Heli-Coil* inserts are used to provide stronger, lighter fastenings, corrosion-proof, wear-proof threads in all assemblies.

FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

FOR SPEEDY REPAIRS: When tapped threads wear, strip or corrode in service, renew them in minutes on location in shop or field with *Heli-Coil* inserts. No welding—no plugging—no secondary machining—no oversize screws.

How they work

Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

What they do for you

Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

Best time to put *Heli-Coil* inserts benefits to your use is right at the designing board, as many leading manufacturers are doing. But to convince you of their many advantages ask for a working demonstration right on your production line. Write today! Complete information and engineering data is available in the *Heli-Coil* catalog. Use Coupon!

*Reg. U.S. Pat. Off.

Approved for All Military and Industrial Uses

7 savings wrapped up in HELI-COIL inserts

These savings are multiplied into major profits this simple way

Use *Heli-Coil** Inserts to:

1. *Save* money by using fewer and smaller screws to do the same holding job.
2. *Save* material—lighter bosses, thinner wall section, smaller flanges.
3. *Save* weight and reduce bulk in assemblies.
4. *Save* assembly time by using cap screws instead of nut-and-bolt assemblies.
5. *Save* rejections in production. Threads damaged on the line are quickly repaired. You save time. Reduce scrap.
6. *Save* on field service costs. No field damage to threads—fortified by *Heli-Coil* inserts.
7. *Save* customer good will by eliminating product failure due to thread fault. Every thread in your product is made stronger, longer wearing with *Heli-Coil* insert protection.

Use the handy coupon to get *free sample* Heli-Coil inserts plus all the data you need to design these savings into your product.

HELI-COIL CORPORATION
150 SHELTER ROCK LANE, DANBURY, CONN.

☐ Send samples and Handbook 652, a complete design manual.
☐ Send samples and put my name on list to receive "Heli-Call," case history periodical.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

How Beryllium Copper Springs keep foods fresher...longer

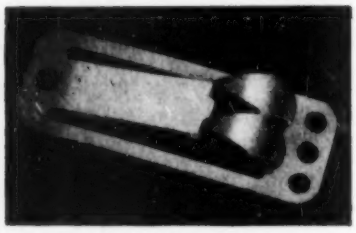
A BERYLLIUM COPPER SPRING is the "memory cell" of the defrosting mechanism of a leading household refrigerator. This small flat spring completely eliminates the necessity for remembering to defrost at the proper intervals. Thus, this beryllium copper spring functions in the defrosting timing cycle of the refrigerator — and through this increased efficiency, it helps keep foods fresher . . . longer.

The design engineers set rigid specifications for this defroster-actuating spring. They wanted, above all, maximum dependability and long life. The production department insisted on early and frequent deliveries after design details had been settled . . . and they wanted them in large quantities. And, naturally, the purchasing office demanded lower unit costs!

There's nothing too exceptional about these specifications. But there *is*, we believe, an unusual story in the manner in which they were exceeded—*on every count!*

I-S Micro-Processed Springs of Beryllium Copper

were chosen and are still being used for this installation because of their 4-way superiority:



You have the identical basic problems—time and unit costs, plus product performance. We feel that this particular spring application clearly demonstrates two important Instrument Specialty features: *(1) our ability to produce a better spring, faster and usually at lower cost to you. (2) the specialized ability of our engineers to cooperate with your designers in meeting practically any exceptional problem that involves spring-making.*

It cost you nothing to compare methods and costs.

(*1*) HIGHER DEGREE OF UNIFORMITY AND dependability than conventionally-made springs.

(*2*) I-S DESIGN ENGINEERS' SPECIALIZED experience in spring-making aided in redesigning for our exclusive "strip spring" technique which permits hardening in multiple fixtures to assure the uniform dimensional and elastic performance. This also resulted in substantial unit-cost reduction.

(*3*) THIS SAME I-S EXCLUSIVE STRIP DESIGN showed further savings in subsequent assembly-line operations—such as cleaning, inspection and attaching of the silver contacts and elimination of costly hand adjustments.

(*4*) ONLY I-S EXCLUSIVE TECHNIQUES, methods and patented equipment could have produced these far superior springs within the time limits set by the production department.

Instrument Specialties Co. Inc.
234 D BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY
Telephone Little Falls 4-0280

For full information on I-S Micro-processed Springs, write today for your free copy of Catalog 7, for Electronic Components, ask for Catalog No. 7-A.

GASKET SAMPLES FOR TESTING

Vellumoid materials in actual service tell their own story of quality and endurance. Send us your gasket problems and our engineering department, backed by years of experience, will work with you.

Ask for our Technical Data Book and samples for testing.

VELLUMOID
444 VELLUMOID
VELBESTOS
(Compressed Asbestos)
VELLUTEX
VELCOREX
VELBUNA
THIOKOL & BUNA N.
Coated

THE VELLUMOID CO.
Worcester (6) : Mass.

Geared to PRECISION PRODUCTION

Write today for your free copy

WORCESTER

Pioneers in precision gears since 1867

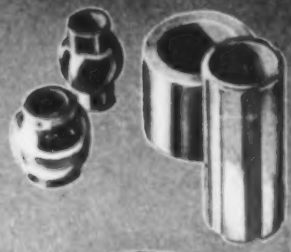
Bevel Gears	Sprockets
Helical Gears	Worms
Spiral Gears	Gear Racks
Spur Gears	Ratchets

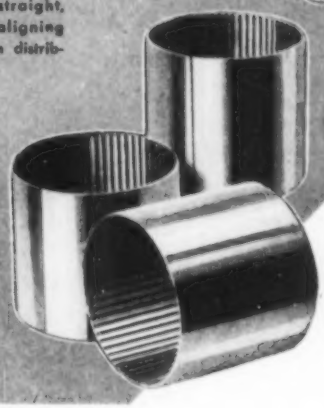
WORCESTER gear works, inc.
26 Grafton St., Worcester 4, Mass.
(See our ad in 1954 Annual Handbook)

Are you looking for a Self-Lubricating Bearing?

JOHNSON LEDALOYL Self-Lubricating BEARINGS

● Produced by powder metallurgy—molded pre-cast bronze alloy—these bearings are impregnated with oil. Made to order in large quantities of a size. A large selection of straight, flanged and self-aligning sizes available from distributor stocks.



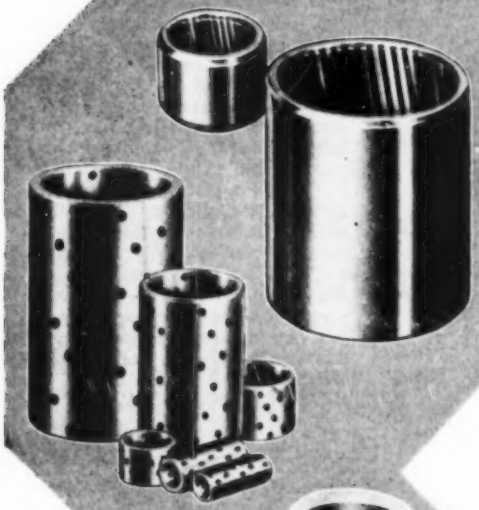


JOHNSON GRAPHITED SHEET BRONZE BEARINGS

● Serrated type. Made to order in wide range of sizes. Low cost in quantities of a size.

JOHNSON GRAPHITED CAST BRONZE BEARINGS KR SERRATED TYPE

● Provides 40 to 45% graphite contact with shaft, increasing slightly with wear. This type is a standard stock item in over 200 sizes, available from Johnson Distributors. Other sizes made to order.



PLUG TYPE GRAPHITED CAST BRONZE BEARINGS

● Stick graphite is forced into drilled holes. Made to order in any size, or produced from any of 900 Standard Stock Size Johnson GP Bearings.

OIL GROOVE TYPE GRAPHITED CAST BRONZE BEARINGS

● Oil grooves serve as recesses to hold graphite. Made to order in any size, or produced from any of 900 Standard Stock Size Johnson GP Bearings.

Oil groove type

JOHNSON GRAPHITED BRONZE BEARINGS and JOHNSON LEDALOYL (Powder Metallurgy) BEARINGS

meet such requirements. They were developed primarily for applications where lubrication is difficult or likely to be neglected. Where shaft speed is too slow or the temperature too low to sustain an oil film, use a Johnson Graphited Bearing. If high operating temperatures may burn out oils and greases, your answer may be a graphited bearing. They are recommended, too, where lubricants may damage goods or foods in process, where dripping oil cannot be tolerated, and in certain underwater applications. Johnson Ledaloyl Self-Lubricating Bearings are impregnated with oil, which is metered to the shaft in operation, reabsorbed when at rest. They are especially desirable for sealed-in applications. Johnson Engineers will gladly help you select the correct sleeve bearing for the job. Write for full information.

JOHNSON BRONZE COMPANY
508 South Mill Street • New Castle, Pennsylvania

JOHNSON JB BEARINGS
Sleeve-Type

OTHER JOHNSON BEARING TYPES . . .

General Purpose (GP) • Electric Motor (EM) • Universal Bronze Bars • Babbitt Metal

ELECTRO MECHANICAL

Engineers

For research and development of electro-mechanical radar and computing equipment.

Significant advancements in the fields of airborne radar and fire control systems are requiring further applications of electro-mechanical techniques in the Hughes Radar Laboratory.

The company

Hughes Research and Development Laboratories, located in Southern California, form one of the nation's leading electronics organizations. The Laboratories are presently engaged in the development of advanced electronic systems and devices which are produced by the Hughes manufacturing divisions.

Areas of work

The work calls for devising reliable, maintainable, manufacturable designs for precision equipment developed in the Hughes Radar Laboratory. The equipment consists of mechanical, electronic and microwave devices and systems to be manufactured in quantity. The equipment designs require the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes and specifications is useful.

The future

Engineers experienced in the field of electro-mechanical design for production or those interested in entering this field will find outlets for their abilities and imagination in these activity areas. New electro-mechanical techniques are opening new applications for airborne electronic equipment. Hughes engineers will have the full benefit of working experience in these fundamental developments.

Assurance is required that the relocation of the applicant will not cause the disruption of an urgent military project.

Address resume to **Scientific and Engineering Staff**

Hughes

Research and Development Laboratories

Culver City, Los Angeles County, California

Have you

TEMPERATURE PROBLEMS IN BEARING APPLICATIONS?

If you do, you can find real help on this subject—as on so many others—in your *Annual HANDBOOK of Product Design for 1953.* An important, carefully detailed report in the *HANDBOOK* explains an empirical formula which enables the designer to specify speed, load, and lubrication requirements so that the bearing operating temperature will fall within safe limits.

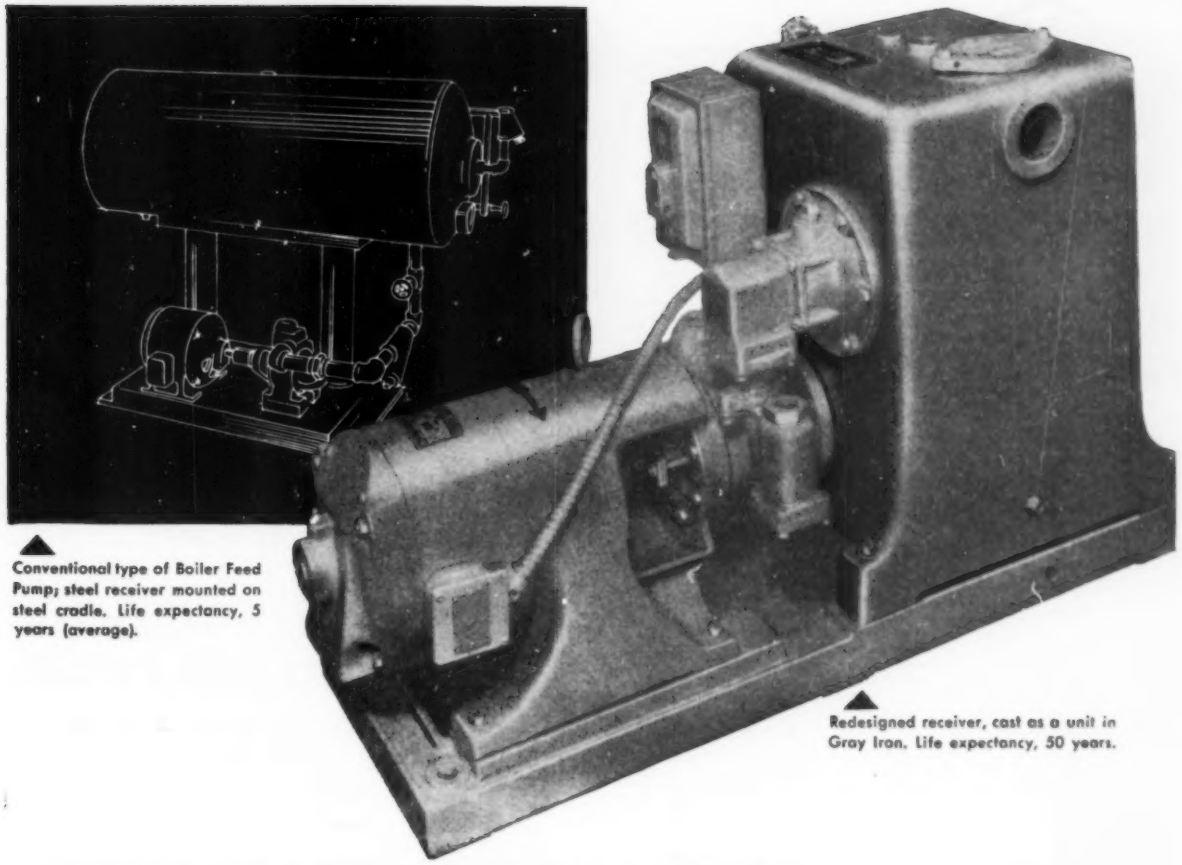
Every new edition of your *Annual HANDBOOK* brings you a wealth of *permanently useful* data representing the significant developments of the year in the field of product-design engineering. This data, painstakingly selected from leading technical publications here and abroad, is specially edited for the *HANDBOOK*—sometimes condensed, sometimes expanded, always fully illustrated by photos, graphs, and charts. The *HANDBOOK* is completely indexed, and sectionalized into ten major classifications for easy reference to subject areas of particular interest to you. The report on operating temperature of bearings mentioned above, for example, is just one of many reports in the sixth section, *Design Analysis and Mechanical Parts,* of the '53 *HANDBOOK.*

In Mid-November, you will receive *The Annual HANDBOOK of Product Design for 1954,* even bigger and more informative than your widely acclaimed *HANDBOOK for 1953.* The new edition will again come to you as part of your regular subscription to *Product Engineering.*

Product Engineering

330 West 42nd Street

New York 36, N. Y.



Conventional type of Boiler Feed Pump; steel receiver mounted on steel cradle. Life expectancy, 5 years (average).

Redesigned receiver, cast as a unit in Gray Iron. Life expectancy, 50 years.

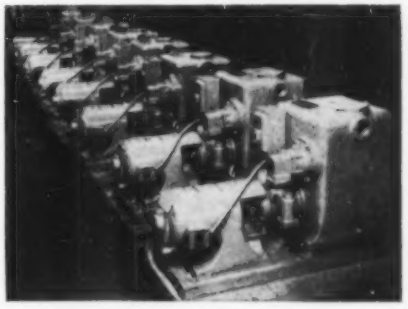
COST SAVINGS BUILT IN by practical use of GRAY IRON!

In Boiler Feed Pumps, first cost is less important than long-time economy. Because water conditions often cause certain materials to deteriorate rapidly, replacement costs are frequently high.

When a leading manufacturer replaced the conventional steel tank with a Gray Iron casting, here's what happened:

- In spite of somewhat higher initial cost, savings at the end of a 5-year period amounted to 38%—including replacement cost of steel tank, plus labor and fittings. This important saving in replacement cost will be realized every 5 years for approximately 50 years.
- By designing for the cast Gray Iron receiver and subbase mounting, space requirements were reduced—excess piping, valves and fittings were eliminated.

Have you analyzed *your* product for possible cost savings which can be accomplished by designing for and with Gray Iron? Write for technical information on the many advantages of the Gray Iron casting process.



Boiler Feed Pumps with Gray Iron receivers, built for U. S. Navy.

Make it Better with Gray Iron . . .
Second largest industry in the metal-working field

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

AEMCO

RELAYS
you can rely on!

A manufacturer's reputation and that of his products are often determined by the performance of relays. Little wonder that more and more design engineers and manufacturers are specifying the "Diamond Seal for Djamond Quality" . . . Automatic Electric Manufacturing Company's Relays.

Unexcelled high standards of material and craftsmanship combine to produce superior relays that are built to exceed—not just meet—the most exacting specifications. Automatic Relays are available in a wide variety of spring and coil combinations . . . operating potentials and contact ratings for an almost limitless variety of applications.

OPEN AND SEALED TYPE RELAYS

Whether your requirements demand plug-in tube base or any of the other standard type mountings,—or a specialized mounting—it will pay you to get complete facts on Automatic Relays with *built-in reliability!* Automatic midgets, dual purpose, delayed make or break, circuit control, current and potential Relays are built to exceed specs, *military or industrial.* If you measure quality by performance, Automatic Relays will measure up!

AEMCO

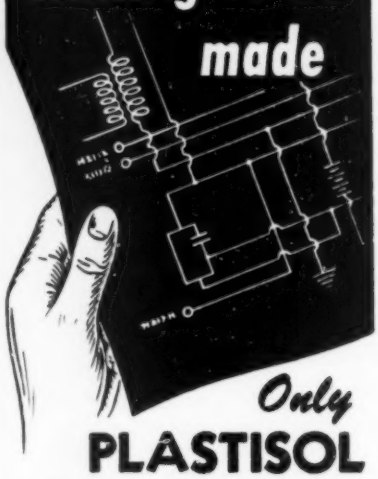
The complete line of Automatic Relays are available to meet military specifications. The facilities of our engineering department are at your disposal. Write, wire or phone. All inquiries will receive prompt attention.

Automatic Electric MFG. CO.

66 STATE STREET · MANKATO, MINN.

ELECTRICAL

For products waiting to be made



Only

PLASTISOL INSULATION

for Molding, Extruding or Dipping can be specifically compounded to produce these advantages:

- Ease of molding or coating—inexpensive molds or equipment required
- Good aging properties under normal operating temperatures
- Low temperature flexibility
- Good outdoor durability
- Resists most acids and alkalis
- Good flame resistance
- Resistance to oil and grease

Whatever you manufacture, from spaghetti wiring to circuit-breaker panels, Stanley chemists can formulate a vinyl plastisol to meet your most exacting insulation requirements. For specific information write *today* to the Stanley Chemical Co., 82 Berlin St., East Berlin, Conn.

Industrial Coatings

STANLEY CHEMICAL

LACQUERS · JAPANS · SYNTHETICS · ENAM...

For the long haul... Autocar relies on RB&W bolts

Famous truck builder rates them best for ease of assembly and accessibility

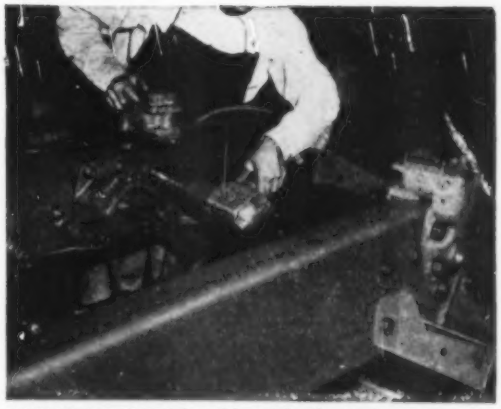
It's been a long time since the Autocar people switched from riveted to bolt-and-nut construction. Here's how it happened:

Two Autocar engineers took off on a coast-to-coast run to shake the bugs out of a new test model. Things went well until a riveted spring bracket broke. It took an entire day just to chisel through the rivets because it was hard to get at the bracket.

From that day on, it was *accessible* bolt-and-nut construction exclusively for all Autocar trucks. And Autocar standardized on RB&W bolts. One dividend from using these rugged bolts is that Autocar can specify higher-strength material than is practical for riveting. Furthermore, tests on structures like bridges show that rivets frequently loosen. This doesn't happen to bolts on Autocar frames.

Where you want to join structural members firmly together so they'll *stay* together for good, high-strength bolting is often your best bet.

As the leading manufacturer of all kinds of fasteners, we're in the unusual position of always being able to recommend and supply the right ones for all your needs. Write to RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY, Port Chester, N. Y.

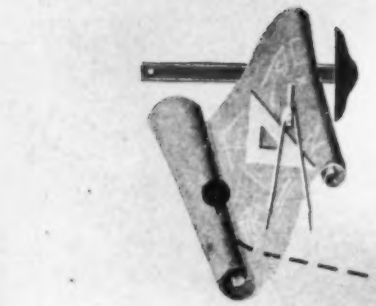


FASTER FASTENING is achieved in the Autocar plant at Ardmore, Pa., by using air tools like the one shown here to run up RB&W nuts on RB&W bolts on an Autocar truck frame. In addition to making tight, accessible joints, bolting effects substantial assembly savings. 3.1

RB&W

108 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

Plants at: PORT CHESTER, N. Y., CORAOPOLIS, PA., ROCK FALLS, ILL., LOS ANGELES, CALIF. *Additional sales offices at:* PHILADELPHIA, PITTSBURGH, DETROIT, CHICAGO, DALLAS, SAN FRANCISCO. *Sales agents at:* PORTLAND, SEATTLE. *Distributors from coast to coast.*



First in

stainless steel

fastenings

ANTI-CORROSIVE METAL PRODUCTS

behind this symbol is an on-hand inventory of *more than 9,000 items and sizes* of stainless steel fastenings. Ready for immediate shipment, this stock is the largest and most complete in the industry. In addition, a production capacity for large or small quantities of special orders is at your service! A good reason — when you think of stainless steel fastenings — to think FIRST of Anti-Corrosive! *Send for Catalog 53M today!*

ANTI-CORROSIVE METAL PRODUCTS CO., INC.
Castleton-on-Hudson, New York

Machinery Design Improved With Slo-Speed

We have used Slo-Speeds for years on many types of special machinery we manufacture and can report complete satisfaction with their performance, states Frank Fluckinger of Fluckinger Machine Works, Seattle. Their streamlined design enhances the appearance of our equipment ... their compact, self-contained construction and versatile mounting features facilitate installation, add to safety in operation, and make them adaptable to our varied requirements.

STERLING SLO-SPEED

GIVES YOU THE ONE BEST LOW SPEED AND

gives uninterrupted service — carries heavy overhung loads — provides versatile mounting and flexibility in arrangement of machinery — saves valuable space — provides greater safety — costs less to install and use. An indispensable source of low speed power for:

Agitators	**Dryers**	**Presses**
Blenders	**Feeders**	**Pumps**
Blowers	**Kilns**	**Screens**
Conveyors	**Mills**	**Tumblers**
Cookers	**Mixers**	**Etc., etc.**

20-page illustrated catalog ... Sterling Speed-Trol, Slo-Speed, Klosd and Klosd-Tite Electric Power Drives. Write for catalog No. 1-C-431.

STERLING ELECTRIC MOTORS

Plants: New York City 51: Chicago, Ill. Los Angeles 22: Hamilton, Canada: Santiago, Chile Offices and distributors in all principal cities

Flying "taxis" that open up new roads

Miraculous rescue flights over Korean combat zones put helicopters in the spotlight. Soon, 'copters like these three leaders will open up more and more new "roads" in America's skies.

Powered by always dependable, air-cooled engines built by Lycoming, these helicopters are already used by industry as flying "taxis" to transport executives from plant to plant. Soon, major cities will get aerocab service from midtown terminals to airport flight lines. Later, every state in the union will get super "taxi" service between cities . . . and even commuter service from suburbs to hearts of business sections.

Dependable Lycoming power has helped these leading helicopters achieve outstanding safety records. This is another Lycoming contribution to America's progress in the air; another reason why we say: "For efficient, dependable, air-cooled power . . . look to Lycoming!"

Air-Cooled Engines for Aircraft and Industrial Uses
Precision-and-Volume Machine Parts
Gray-Iron Castings • Steel-Plate Fabrication

DOMAN LZ-5. Powered by a Lycoming 400-h.p. engine. Speed, 110 m.p.h. Range, 220 miles.

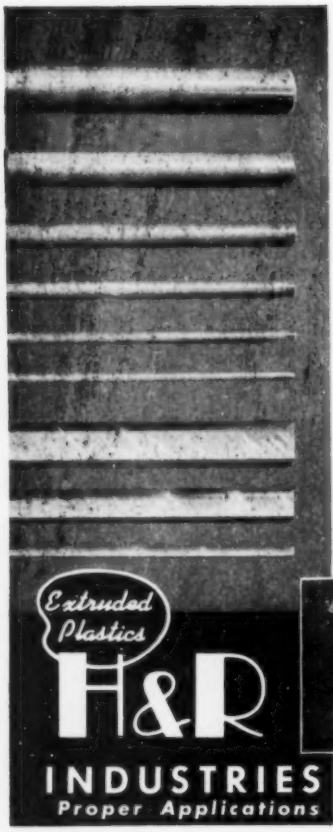
KAMAN K-240. Powered by a 250-h.p. Lycoming engine. Speed, 90 m.p.h. Range, 210 miles.

PIASECKI H-21. Powered by a 1425-h.p. Lycoming-built engine.* Speed, over 115 m.p.h. Range, over 200 miles.

FOR RESEARCH • FOR PRECISION PRODUCTION
LOOK TO **LYCOMING**

Lycoming-Spencer Division, Williamsport, Pa. — AVCO — Bridgeport-Lycoming Division, Stratford, Conn.

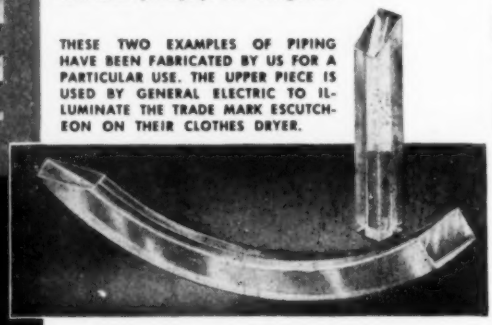
*Wright-Cyclone engine, built by Lycoming under license from Curtiss-Wright Corporation, Wright Aeronautical Division.



Light ...Where and How you want it!

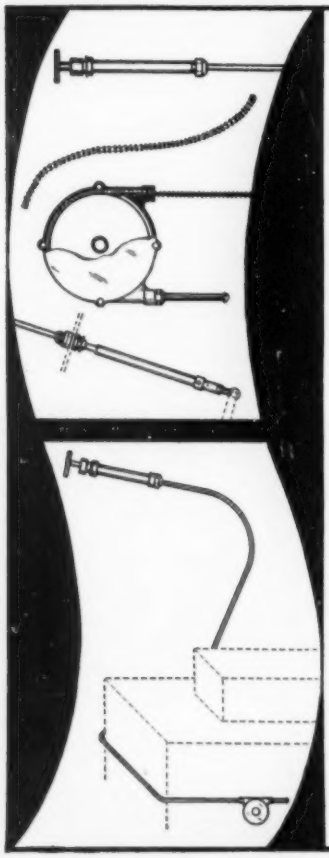
Acrylic piping can provide a simple, effective solution to problems of lighting "hard-to-get-at" locations.
Acrylic rods and shapes—round, square, triangular, curved—"travel the light" the length of the piping. They can be formed to any shape . . . "S" curves, ovals, even "corkscrew" turns . . . then cut at the desired exit point to emit the light where you need it.
H & R supplies Acrylic piping in continuous lengths or fabricated to exact specifications for immediate use. Samples, suggestions and prices furnished promptly. No obligation!

THESE TWO EXAMPLES OF PIPING HAVE BEEN FABRICATED BY US FOR A PARTICULAR USE. THE UPPER PIECE IS USED BY GENERAL ELECTRIC TO ILLUMINATE THE TRADE MARK ESCUTCHEON ON THEIR CLOTHES DRYER.



Extruded Plastics
H&R
INDUSTRIES
Proper Applications

NAZARETH, PENNA.
. . . Product Improvement



TELEFLEX

MECHANICAL REMOTE CONTROLS

Unlimited Rotary Motion—Meshing of Teleflex screw-type Cable with specially hobbed gears housed in Teleflex Control Boxes permits unlimited shaft rotation.

Efficiency—The unique construction of Teleflex Cable provides control systems that operate efficiently in both tension and compression.

Minimum Lost Motion—Close tolerances held between Teleflex Conduit and the Cable reduce snaking of the cable within the conduit.

Flexibility—Teleflex conduit and cable can be routed around obstructions and through areas where space is limited.

Ease Of Installation—Teleflex Controls are assembled on-the-job from standard Teleflex parts. Prefabricated controls are available for short run controls.

Engineering data for calculating operating loads and backlash is available upon request.

Write now for our latest brochure 302B

TELEFLEX INCORPORATED
125 So. Main Street No. Wales, Pa.

TRANSPOSING an idea into a finished product involves not only the use of engineering drawings but—with form as well as function becoming increasingly important—such illustrative techniques as renderings in crayon and smootch, chalk sketches, scale and full size models, and other types of pictorial presentations.

THESE techniques, although most closely associated with the industrial designer's needs, are also useful engineering tools. Their advantages and limitations, and the methods for transposing them into engineering drawings, are fully discussed and illustrated in our Special Editorial Report . . .

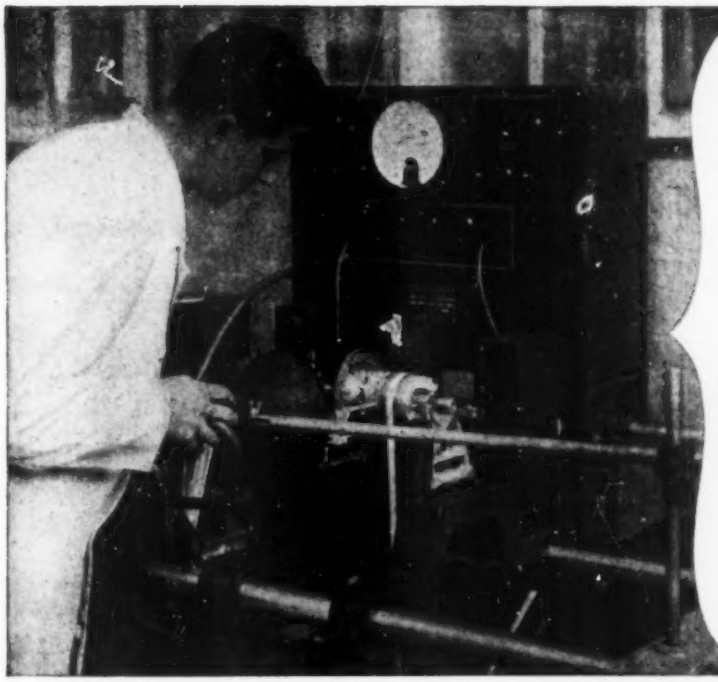
THE MECHANICS of INDUSTRIAL DESIGN

Reprints available at 25¢ per copy

Reader Service Department

Product Engineering

330 W. 42ND STREET
NEW YORK 36, N. Y.



ACEC

OUTSTANDING DYNAMIC BALANCE

ACEC Motors are dynamically balanced far in excess of NEMA standards at no extra cost. Maximum amplitude of vibration of ACEC Motors measured according to NEMA-MGI-4.21 (Oct. 1949) specification.

Location of Measurement	3 HP 1800 RPM	5 HP 1800 RPM
Pulley End Bearing Housing:		
Horizontal Amplitude	0.00035	0.00025
Vertical Amplitude	0.00025	0.00025
All other parts of Motor	0.00020	0.00015 to 0.00020

NEMA (MGI-4.20) Recommended Standard

Frame Sizes	Amplitude in Inches
203-254	0.00100
284-364	0.00150
365-505	0.00200

THESE QUALITY + FEATURES SHOW WHY ACEC MOTORS DELIVER BETTER PERFORMANCE

Dynamic balancing far in excess of NEMA Standards, as shown above, practically eliminates vibration. Equal load distribution on bearings obtained in ACEC design greatly prolong life of these bearings—assures a longer lasting, smoother running motor *at no extra cost to you.*

Tightly sealed bearing enclosures keep lubricant in and dirt and foreign particles out. ACEC motors operate at any angle.

Rounded stator slots top and bottom assure tighter fitting stator windings—eliminate voids that collect dirt and moisture, shorten insulation life.

"Baked-on" insulation. Oven-dried polyvinyl-acetal insulated windings receive two additional coats of "baked-on" plastic insulating varnish for maximum dielectric strength.

Simple, rigid assembly results from cast iron frame and end shields and use of 4 through-bolts with 8 nuts. End shields can be removed without disturbing bearings on shaft.

Rigid quality control maintains quality of materials used in ACEC motors within the narrowest limits. Every motor receives thorough testing—carries a factory guarantee.

ACEC Motors offer these and many other quality features, *yet they're priced below most other motors.* Manufactured strictly to NEMA Frames and Specifications by one of the world's largest electrical manufacturers, they are **available** in a wide variety of types from **300 ACEC Distributors and Service Shops** across the nation.

No matter what your motor requirements, it will pay you to investigate ACEC's top-level performance *at lower prices* by writing to the addresses listed below.

Open Drip Proof ACEC MOTOR

BELGIAN ELECTRIC SALES CORPORATION

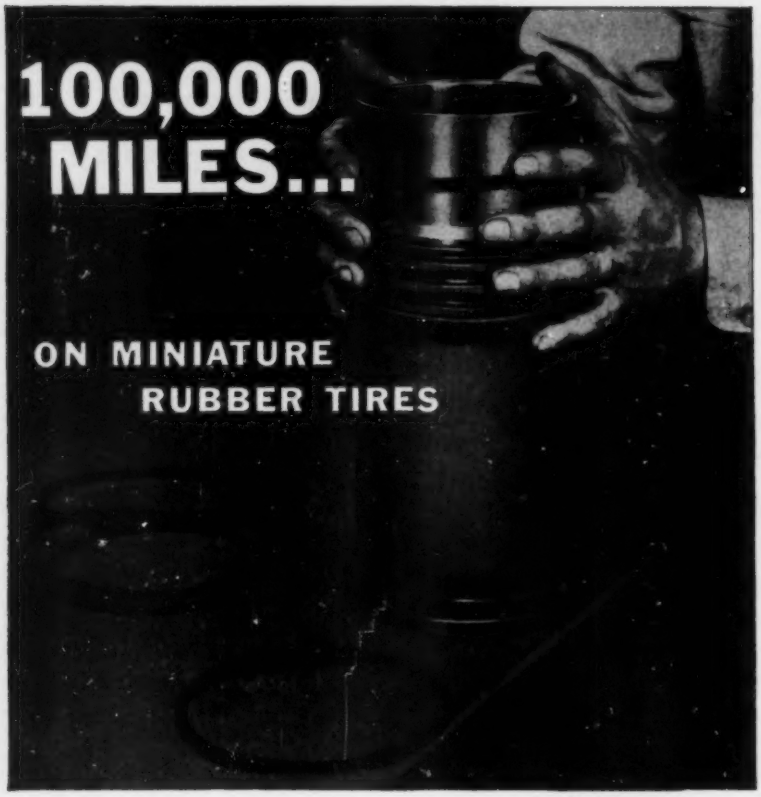
New York City: 40 E. 49th St. PLaza 8-3105

Los Angeles: 423 E. 3rd St. MAdison 6-4421

Sales Engineers & Agents in Principal Cities

CHARLEROI CAEC

ACEC Motors



Photograph courtesy of
Cummins Engine Company, Inc., Columbus, Indiana

Tire-shaped rubber packing rings for cylinder liners in Cummins diesel engines are small but important. They provide a seal between oil and water—a seal that must be perfect whether the engine is cold or operating at high temperatures. Moreover, these rubber rings must stand up for at least the equivalent of 100,000 miles of operation.

These severe operating requirements presented a rubber problem with exacting specifications: resistance to sustained heat—controlled swell in oil—exceptional compression quality—precision tolerances.

Continental met all these specifications and produced a rubber ring that gives outstanding service in an outstanding diesel engine.

The successful production of this specialized rubber part is typical of the complete service in rubber offered by Continental.

When *you* need molded or extruded rubber parts, why not enlist the assistance of Continental?

LET US SEND YOU THIS CATALOG

This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

See our Catalog in Sweet's File for Product Designers

MANUFACTURERS SINCE 1903

CONTINENTAL
RUBBER WORKS

1982 LIBERTY STREET • ERIE 6, PENNSYLVANIA

BRANCHES

Baltimore, Md.	Cleveland, Ohio	Kansas City, Mo.	Pittsburgh, Pa.
Boston, Mass.	Dayton, Ohio	Los Angeles, Calif.	Rochester, N. Y.
Buffalo, N. Y.	Detroit, Mich.	Memphis, Tenn.	St. Louis, Mo.
Chicago, Ill.	Hartford, Conn.	New York, N. Y.	San Francisco, Calif.
Cincinnati, Ohio	Indianapolis, Ind.	Philadelphia, Pa.	Syracuse, N. Y.

* SINCE 1920 * in the application, design and mfr. of pumps — separators — hydraulic accessories

Simplex & Duplex SEPARATORS

*Listed by Underwriters Laboratories

STRAINERS • FILTERS • STANDARD AND HIGH PRESSURE

ELIMINATE LIFTING JACKS

Kraissl Class 72 duplex separators are designed so that you don't need to use a lifting jack to raise the rotary plug valve. The valves are designed to a sufficiently wide angle taper — so that the plug does not wedge on its seat, through wear and use.

Grit, scale and extraneous abrasive matter settle on the seat face, from using a lifting jack. Then, when the plug is returned to its seat and the valve rotated, the seat is galled and scored. This terminates the serviceable life of your separators — and skyrockets your maintenance and overhaul costs.

Complete range of sizes—from 1¼" to 6"; pressures to 500 psi. Cast-iron, bronze, steel, stainless-steel, also aluminum, monel or special metals to your specifications.

Bulletin A-1214 gives full data —write for your copy today!

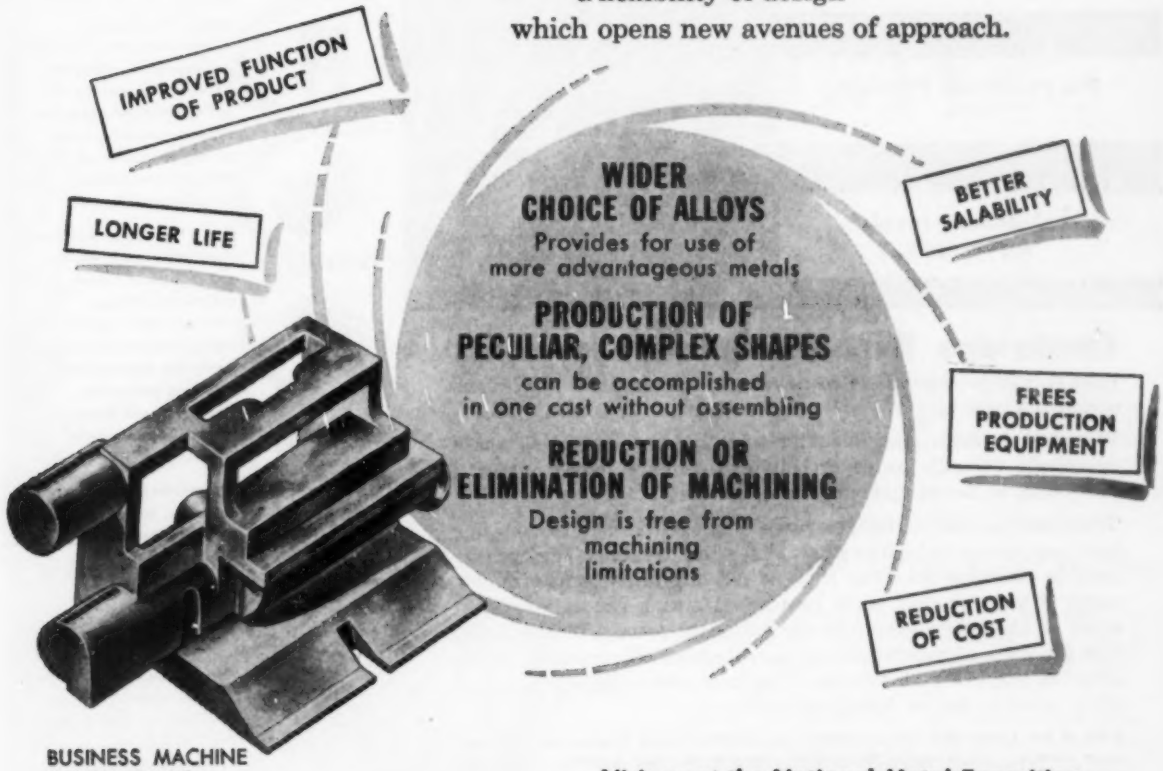
KRAISSL CO

289 Williams Ave., Hackensack, N. J.

*NEW HORIZONS

...for DESIGN ENGINEERS

*To the engineer who is seeking
more DESIGN FREEDOM,
Arwood Precision Castings offer
a flexibility of design
which opens new avenues of approach.


IMPROVED FUNCTION OF PRODUCT
LONGER LIFE
WIDER CHOICE OF ALLOYS
Provides for use of more advantageous metals
PRODUCTION OF PECULIAR, COMPLEX SHAPES
can be accomplished in one cast without assembling
REDUCTION OR ELIMINATION OF MACHINING
Design is free from machining limitations
BETTER SALABILITY
FREES PRODUCTION EQUIPMENT
REDUCTION OF COST

BUSINESS MACHINE
PUNCH GUIDE

This part was expensively machined originally from bar stock and subsequently designed as a sand casting.

ARWOOD ENGINEERS REDESIGNED THIS PART as an investment casting, resulting in 25% reduction in machining time and savings of nearly 50% in metal.

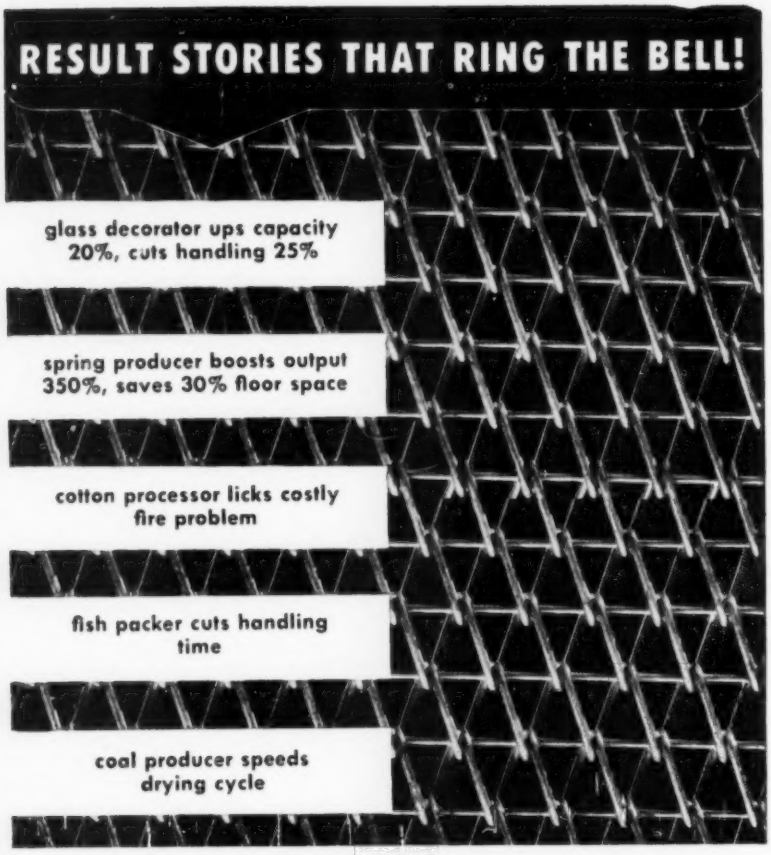
Slippage was eliminated and positive contact assured by changing to a more advantageous alloy, creating improved efficiency in performance of the part.

Additional savings also were obtained by reduction of reject parts.

**Visit us at the National Metal Exposition
Cleveland Public Auditorium
Cleveland, Ohio. Booth #1428.**

ARWOOD
PRECISION CASTING Corp.
68 WASHINGTON STREET B'KLYN 1, N. Y.
Plants: Brooklyn, N. Y. • Groton, Conn. • Tilton, N. H.

RESULT STORIES THAT RING THE BELL!


glass decorator ups capacity 20%, cuts handling 25%
spring producer boosts output 350%, saves 30% floor space
cotton processor licks costly fire problem
fish packer cuts handling time
coal producer speeds drying cycle

Cambridge Wire Mesh Conveyor Belts

have helped produce these cost-saving results in plant after plant across the nation.

Wouldn't it be a good idea for you to investigate how these amazingly versatile conveyor belts can combine movement with processing in the equipment you are building?

They can be used at temperatures ranging from sub-freezing for food packers, to as high as 2100° F. for heat treating. They can be used in corrosive solutions such as pickling acids or in ordinary water if your product must be washed during processing. Open mesh of the belt allows free circulation of process atmospheres, free drainage of process solutions. All-metal construction means long life and low maintenance. They're available in any metal or alloy, mesh or weave, length or width.

Best of all, Cambridge has a solidly experienced Field Engineering staff at your service. Look under "Belting-Mechanical" in your classified telephone book for the man nearest you. Call him in at any time.

Incidentally, we'll be glad to send you details on any of the result stories described in the heading of this advertisement.

FREE, FOR YOUR OWN STUDY —NEW, 140 page Cambridge Belt Catalog illustrates and describes wire mesh belt specifications, gives conveyor design sketches and metallurgical data. It's must-reading for economy minded designers! Write for yours!

The Cambridge Wire Cloth Co.

WIRE CLOTH · METAL CONVEYOR BELTS · SPECIAL METAL FABRICATIONS

Department P
Cambridge 10,
Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Specify

ADVANCE RELAYS

for precise circuitry

There are many reasons why Industry specifies ADVANCE RELAYS: They meet or surpass Military and Civilian requirements—many types have AN approval—many are hermetically sealed—*all* are lightweight—small—rugged—compact—and *all* are precision-built for efficient, trouble-free, long life performance.

If you have relay problems involving contact loads, coil resistances, close differential, timing features, input sources, critical environment or any particular requirements involving unusual or accurate circuit behavior, ADVANCE can supply the relay.

A complete line of relays for radar, radio, electronic and electrical equipment applications.

Write for new, descriptive Catalog containing detailed information about ADVANCE Relays and facilities.

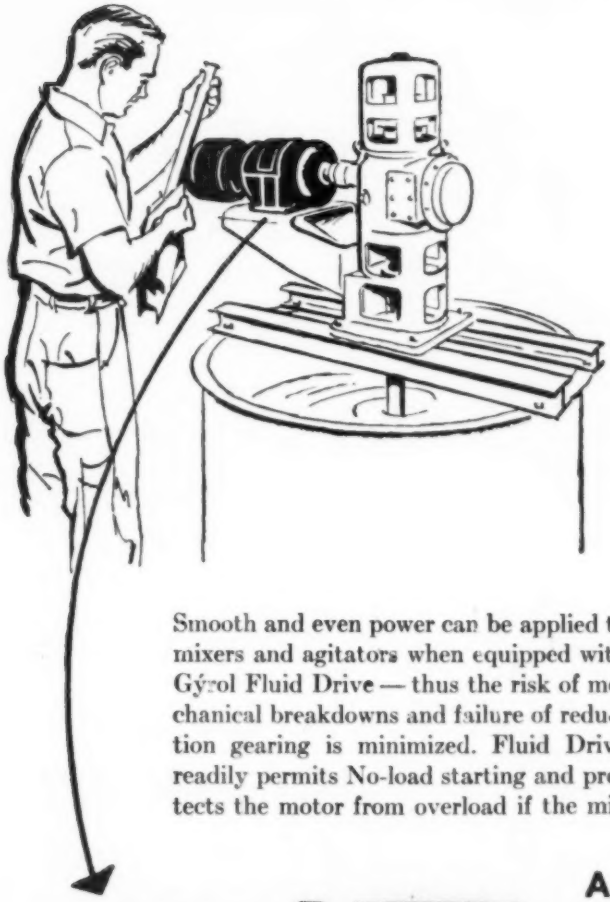
ADVANCE ELECTRIC AND RELAY COMPANY

ADVANCE RELAYS

2435 NO. NAOMI ST.,
BURBANK, CALIF.

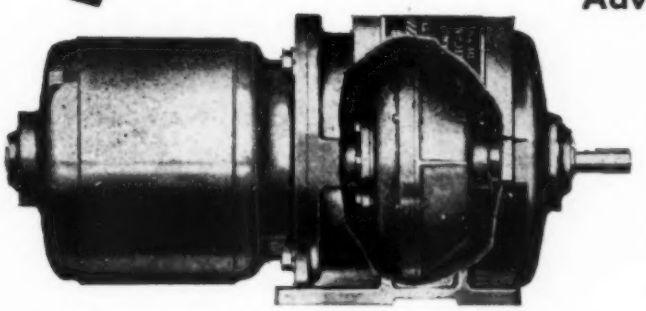
Sales Representatives in Principal Cities of U.S. and Canada

Get smooth power on mixers and agitators with



GÝROL FLUID DRIVE

Smooth and even power can be applied to mixers and agitators when equipped with Gýrol Fluid Drive — thus the risk of mechanical breakdowns and failure of reduction gearing is minimized. Fluid Drive readily permits No-load starting and protects the motor from overload if the mix becomes too heavy. Even when high starting torque is necessary, Fluid Drive and a general purpose motor can fulfill starting requirements. Simple cross-the-line starters can be used. Maintenance saving alone will justify a Gýrol Fluid Drive. Ask our nearest branch office.



Cutaway view of Type TM Gýrol Fluid Drive unit

Advantages of American Blower Type TM Gýrol Fluid Drives

- Provides smooth flow of power. Shocks are absorbed in a cushion of oil. There's no metal-to-metal contact between driving and driven machinery.
- Offers by its inherent shearpin action, selective overload protection for both motor and driven machinery. Decreases machine "down" time.
- Available as a complete packaged unit suitable for either direct or belt connection to the driven machine. Minimizes alignment problems.

Free trial units available to original equipment manufacturers

American Blower Corporation, Detroit 32, Mich.
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

biological specimens

.000 000 98425

INCH THICK

cut with the

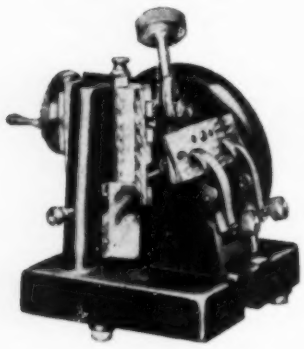
MICROTOME

which uses

11 HITCHINER

precision investment

CASTINGS



International Equipment Co., Boston, Mass., manufactures the Microtome shown and other precision instruments. For the Microtome, they chose Hitchiner precision investment stainless steel castings because they could get extremely accurate parts with a minimum of machining. These castings also lend themselves to the very high, bright, smooth finish necessary on instruments of this quality.

Whatever your requirements may be in small castings, we will be happy to have you utilize our facilities and experience in solving your parts problems. Quotations furnished promptly on receipt of your prints.

BE SURE TO SEE US AT SPACE 2422, THE NATIONAL METAL SHOW

HITCHINER Manufacturing Company, Inc.

MILFORD 4, NEW HAMPSHIRE

Representatives in principal cities.

How Can a Man Keep Track of Everything Happening in this Field of Design Engineering?

It's not easy! That's the principal reason behind the establishment of *The Annual HANDBOOK of Product Design* as a continuing yearly service to product-design engineers.

To produce your yearly *HANDBOOK, Product Engineering* editors select from a great many technical publications the data which will be most valuable for year-after-year reference, and most immediately helpful to you in your job. They pick and choose, condense where it will save you time, expand where a broader treatment or a more detailed report can better clarify the significant engineering developments of the year for you.

Both the editorial and advertising pages of the 1954 *HANDBOOK* will be sectionalized by ten major subject classifications, and both will be completely indexed, enabling you to locate easily the data on any subject of particular interest to you.

The Annual

HANDBOOK

of Product Design

for 1954

will be ready

in Mid-November

The *HANDBOOK for 1954*, with an even broader editorial coverage of your interests than the enthusiastically welcomed *HANDBOOK for 1953*, will be published in Mid-November. As before, you will receive your *HANDBOOK* at no extra cost, as part of your regular subscription to *Product Engineering*.

Product Engineering

330 West 42nd St.

New York 36, N. Y.

In visualizing AUTOMATIC ELECTRONIC CONTROLS for your equipment, think of them LIKE THIS

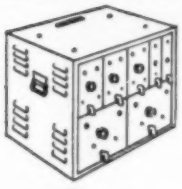
Are your prospects afraid of the "Little Black Box?"

Your wonderful new Electronic Controls may mean the death of a sale — unless the cautious buyer sees that his own personnel can locate and correct Control troubles on the spot.

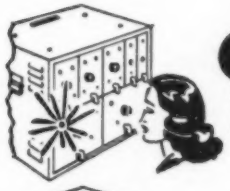
Any electronic equipment can now be subdivided into simple plug-in units that for the first time assure your users RELIABILITY IN SERVICE

(The User's own personnel can locate and correct most troubles on the spot)

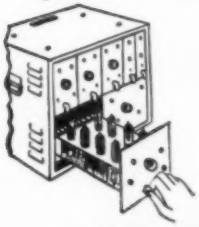
Here are the bold new Standards:



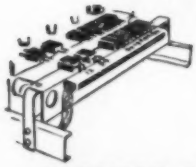
1 Circuitry subdivided, function by function into plug-in units.



2 Tiny telltales spot trouble instantly.



3 Plug in replacement spares in 30 seconds.



4 All leads brought to single accessible point of check — all numbered, color-coded — so layman can make first-level tests.

REQUEST FREE HANDBOOK

Describing complete system of Plug-in Unit Construction and Components. 226 pages and many Planning Sheets.

Here's how to get them: IT'S AS SIMPLE AS THIS –

1. *Utilize your circuitry in compact vertical planes using Alden Terminal Card Mounting System.*

PREPUNCHED TERMINAL MTG. CARD
MINIATURE TERMINALS
JUMPER STRIP Eliminates wiring for common circuits
CARD-MTG. SOCKETS
YOUR COMPLETED CIRCUITS FOR PLUG-IN PACKAGE OR CHASSIS

You can use Alden Terminal Mounting Card with Alden Miniature Terminals, Jumper Strip and Sockets staked to accommodate any circuitry — making complete units ready for housing. Components snap into unique Alden Terminals, are field ready for soldering.

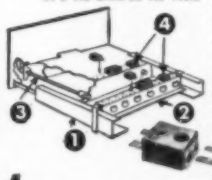
2. To mount this vertical circuitry, ALDEN PLUG-IN PACKAGES AND BASIC CHASSIS give tremendous variety with standard components

ALDEN PLUG-IN PACKAGE
4 SIZES: 7-, 9-, 11-, & 20-PIN
ALDEN BASIC CHASSIS 2", 4", 8" & 17" widths
Plugged into Standard Racks
Plugged into Alden Uni-Racks
Plugged into Portable Cases

Standard Alden components provide tremendous variety to build almost any circuitry as plug-ins. With spares, your circuits are units replaceable in 30 seconds.

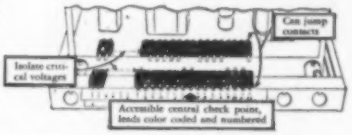
3. Give chassis easily traceable interconnects and 30-second replacement with ALDEN SERVE-A-UNIT KIT

IT'S AS SIMPLE AS THIS



Arrange Alden Side Rails (1) and Alden Lock Frame (2) to suit your chassis. Alden Serve-A-Unit Locks (3) mount in your chassis to engage pre-punched holes in Alden Lock Frame (2) to pilot, draw in, lock or eject your chassis. Arrange Alden Back Connectors (4) in orderly row on Alden Lock Frame. Mount mating Alden Back Connectors on your Chassis.

GIVING YOU 1) Chassis that plugs in, locks and ejects with half turn of the wrist. 2) leads so beautifully organized, accessible and identified that non-technical personnel can service.



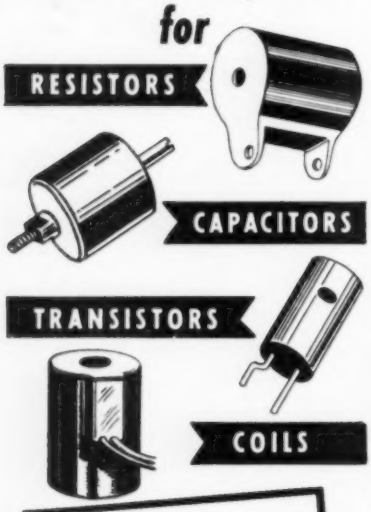
4. *Assign to each unit ALDEN SENSING ELEMENTS — to spot trouble instantly:*

Compact front panel easily mounts 6 tiny Alden Sensing Elements — specifically designed to lick the problem of small space.

By thinking of your Electronic Controls in terms of ultimate plug-in units — you lick the problem of RELIABILITY IN SERVICE for your Customer . . . and you wash out problems of Design, Manufacture and Procurement for all concerned.

NA-ALO **ALDEN PRODUCTS CO.** 135 N. Main St., Brockton 64, Mass.

HYSOL 6000 Series Compounds provide Excellent Properties for



HYSOL epoxy compounds are used extensively for impregnating, potting or encapsulating electronic components like those illustrated above. HYSOL 6000 Series compounds are specified because Houghton Laboratories Inc. has cooperated with its customers, not only in the development of a specific material for a specific purpose, but also in the development of methods of making molds and follow thru to product acceptance.

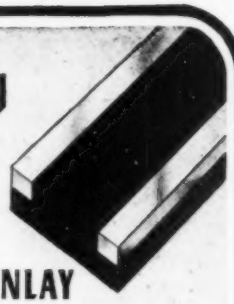
Why not call on the HYSOL technician when you want product improvement? We can "work it out" together in your laboratories or ours. Our frank, honest opinions are yours for the asking.

PROGRESSIVE PRODUCTS THRU CHEMICAL RESEARCH

HYSOL
Product of HOUGHTON LABORATORIES, INC.

houghton laboratories, inc.
345 Bush St.
OLEAN, NEW YORK

For Resiliency and Strength use "IMPROVED'S" SILVER OVERLAY OR INLAY



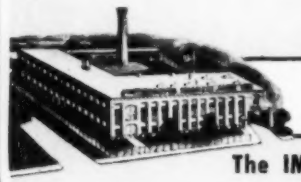
Among the many fine quality "IMPROVED" products, will be found fine or coin silver permanently bonded to the non-ferrous base metal most suitable for your application.

You will have the high electrical conductivity of a solid silver contact while enjoying the strength, resiliency and economy of the non-precious metal as a supporting base.

Maximum width 5" – Minimum width ¼" – Minimum thickness .003" – Maximum tolerance 5% all dimensions.

Why not send us your blueprints or specifications for quotation without obligation?

Write now for free booklet,
"The Story of Laminated Metals"

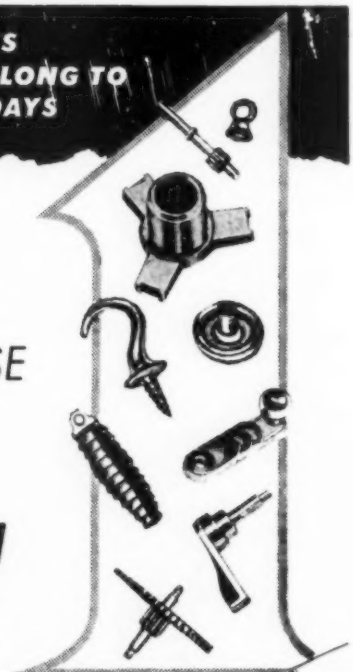


The Home of IMPROVED Service
Rhode Island's largest manufacturer of Laminated Metals

The IMPROVED SEAMLESS WIRE COMPANY
INCORPORATED 1898
775 Eddy Street, Providence 5, Rhode Island

MULTIPLE ASSEMBLIES FOR SMALL PARTS BELONG TO HORSE-AND-BUGGY DAYS

GRIES
DIE CASTINGS GIVE YOU TINY PARTS LIKE THESE
COMPLETE IN ONE OPERATION



Compare GRC small die castings with assemblies produced by other methods. GRC completely finished parts save you time, labor, money. Cast in one high-speed operation, they open broad opportunities for your new designs. Fast delivery on 100,000 pieces to many millions.

Write today for bulletin and samples.
Send prints for quotations.

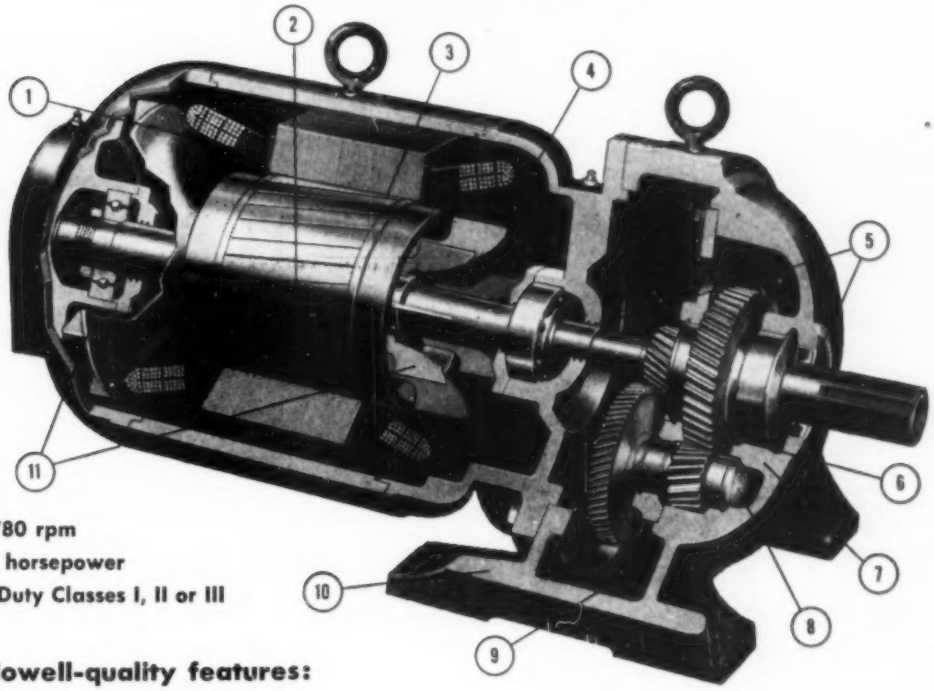
America's Foremost *Producers* of Tiny Die Castings

GRIES REPRODUCER CORP.
Manufacturers of Small Castings Exclusively
159 Beechwood Ave., New Rochelle, N. Y., NEw Rochelle 3-8600

Smallness Unlimited
Max. Wt.: ½ oz.
Max. Lgth.: 1¾ in.

New dependability for gear motor users!

New Howell Gear Motors give greater starting torque plus top efficiency, with output speeds as low as 7.5 rpm.



7.5 to 780 rpm
1 to 30 horsepower
AGMA Duty Classes I, II or III

Typical Howell-quality features:

1. **High-quality insulation.** Complete insulation in each slot cell, between top and bottom coils, and between phase groups.
2. **Copper-clad rotor.** Copper bars and end rings welded or brazed together for unusual strength.
3. **Expert craftsmanship.** Rotors are ground to precision limits for exact concentricity and uniform air gap, and are dynamically balanced at rated speeds.
4. **High-quality coil varnish.** Entire stator is thoroughly impregnated twice with the finest phenolic resin-base varnish and twice baked for extra protection.
5. **Leakproof oil seals.** Assure dependable, dirt-free operation.
6. **Duti-Rated Lifetime Gearing.** Specially machined, file-hard tooth surfaces and tough, resilient cores give high efficiency and long wear-life.
7. **Unit case construction** with integral bearing housings and heavy-duty bearings. Maintains accurate gear alignment under heaviest loads.
8. **Corner-mounted offset shaft.** Saves space and offers a neater over-all design.
9. **Large oil reservoir.** Provides efficient splash-lubrication for cooler operation and minimum gear wear.
10. **Heavy, cast-iron construction.** Thick, sturdy sections and pyramidal base for maximum rigidity and resistance to load stresses.
11. **Superior cooling.** Fans direct air through liberal passages to vital parts of motor.

Single Reduction Double Reduction Triple Reduction

HOWELL Red Band MOTORS

HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MANUFACTURERS OF PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

FREE! New bulletin gives selection procedure for gear motors, typical applications, construction features. Clip coupon . . . fill in and mail today!

• • •

HOWELL ELECTRIC MOTORS CO.
Department PE
Howell, Michigan

Send new Gear Motor Bulletin (GM-1) to:

Name_____

Title_____

Company_____

Street_____

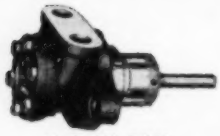
City_____ Zone____ State_____

The VIKING LINES are COMPLETE!

for:

LUBRICATING PUMPS

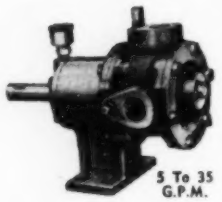
Pumps built for bearing lubrication service up to 500 psi handling lubricating oils. Ask for free bulletin 1803X.



½ To 3½ G.P.M.

COOLANT PUMPS

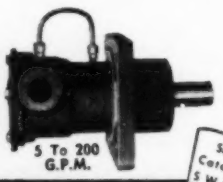
Viking coolant pumps feature the relief rotor . . . no bypass needed. Handy port location. Just turn casing in bracket to fit your piping. Ask for free bulletin 1100X.



5 To 35 G.P.M.

HYDRAULIC PUMPS

Suitable for pressures up to 500 psi on hydraulic oils, intermittent service. 250 psi on continuous service. *Ask for free bulletin 303X.*

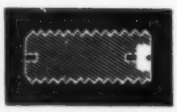


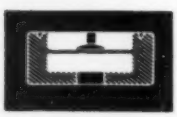
5 To 200 G.P.M.

See Our Catalog in SWEETS

VIKING PUMP COMPANY
CEDAR FALLS, IOWA

Bird COMPLETE JEWEL ASSEMBLIES WILL SPEED YOUR PRODUCTION





You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

Bird Jewel Assemblies are furnished in the right mounting, rigidly inspected according to your specifications, ready for your assembly operations. Make a test — find out how Bird Jewel Assemblies can help your production. Send us a print of your specifications, and we'll provide samples for your own testing.

Our engineering staff is at your service for all small bearing problems.

Over 40 years of serving industry with Quality jewel bearings

Richard H. Bird & Co., Inc.

Sapphire and glass jewels · Precision glass grinding · Ferrite precision products · Sapphire stylii

1 Spruce Street, Waltham 54, Mass.

How to Benefit From Double-Purpose

TEXTURED ORGANIC COATINGS

8 pages—25 cents a copy

Textured organic coatings serve the double purpose of protecting metals and furnishing finishes of unusual eye-appeal. These coatings are extremely useful as they obscure marks left on metallic surfaces by production and finishing operations effectively with one coat.

All the latest information on these "special effect" coatings is available to you in this report. Included is an invaluable chart showing suggested uses, application methods, properties, and color possibilities.

Copies of other reports in this series on improved product appearance and protection are also available.

WHICH COATING FOR GRAY IRON?
8 pages—25 cents a copy

IDENTIFYING YOUR PRODUCT
8 pages—25 cents a copy

ELECTROLYTIC AND CHEMICAL COATINGS
8 pages—25 cents a copy

TEXTURED ORGANIC COATINGS
8 pages—25 cents a copy

HOW TO PLAN PRODUCT COLORS
8 pages—25 cents a copy

FINISHES FOR ALUMINUM PRODUCTS
8 pages—20 cents a copy

SELECTING ORGANIC COATINGS FOR METAL PRODUCTS
8 pages—15 cents a copy

PHOSPHATE COATINGS FOR MILITARY PRODUCTS
8 pages—25 cents a copy

WRITE TO READER SERVICE DEPARTMENT:

Product Engineering
McGraw-Hill Building
New York 36, N. Y.

Don't Miss Your Chance to Win a Fine Camera

Enter the Peerless Photocopy Contest

Only two more months. Complete set of prizes awarded both months

1st PRIZE Your choice of:

Contessa 35 Tessar f/2.8, retail price $216.00
Ikoflex IIa Tessar f/3.5, retail price $216.00

2nd PRIZE Contina I Tessar f/2.8, retail price $119.00
(choice) Ikoflex Ia Novar f/3.5, retail price $125.00

3rd PRIZE Nettar IIc Novar f/6.3, retail price $41.70

1st Prize—Contessa 35
An outstanding 35 mm camera with 45 mm Zeiss Opton coated Tessar f/2.8 lens. Automatically focused by a built-in combined view- and range-finder. Has built-in photo-electric exposure meter. Synchro Compur shutter is fully synchronized. Speeds from 1 to 1/500 sec.

1st Prize—Ikoflex IIa
A truly fine reflex camera with Zeiss Opton coated Tessar f/3.5 lens, in Synchro Compur fully synchronized shutter. Speeds from 1 to 1/500 sec.

The cameras listed above will be sent to the winners of this contest at absolutely no cost. All cameras come complete with top-grain leather carrying cases. All carrying charges prepaid.

HERE'S HOW YOU CAN WIN

The contest is open to everyone actively interested in industrial photocopy.

Write a report on one of the photocopy applications or photocopy techniques that you find most valuable in your business. There is no limit to the length of your report. It can be supplemented with examples of the result achieved, sketches of the process, anything which you feel will lead to a full appreciation of your use of photocopy. Although originality is important, the significance of the result achieved will determine the winners.

Example: Suppose you use photocopy to eliminate certain drafting steps such as the redrawing of an entire part in order to make a simple change. Tell in your report exactly what steps you take to get the desired result. Tell also what this means to your drafting department in terms of time saved. Name the paper and machines involved in your process, and tell why you use them. Remember, the more complete and understandable your report, the better your chance to win.

Only two months left!

DON'T DELAY!
Send your report to:

To qualify for this month's awards, entries must be postmarked no later than November 10, 1953.

To qualify for next month's awards, entries must be postmarked no later than December 10, 1953.

THE JUDGES

The contest will be judged by the executive board of Industrial Photography magazine: Ben Zale, Editor; Lloyd E. Varden, Scientific-Technical Editor; David B. Eisendrath, Jr., Technical Editor. The winners will be reported after each closing date.

YOUR REPORT IS A VALUABLE CONTRIBUTION TO THE INDUSTRY

We are planning to publish the winning reports as a portfolio of modern photocopy practices. The purpose of this portfolio will be to show how valuable photocopy is as an industrial tool, and as evidence of what is being done by experts in the field. No report will be published in the portfolio, or used in any other advertising or promotional material without your written permission and that of the company involved.

PEERLESS PRODUCTS

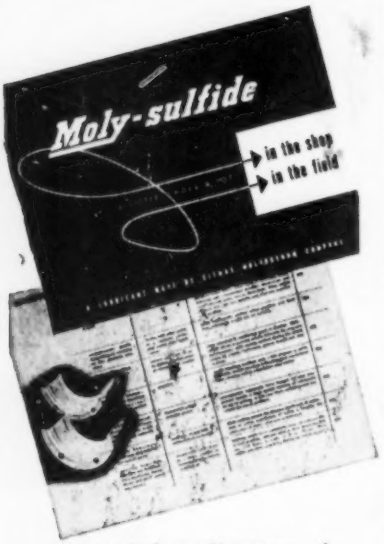
Peerless is one major manufacturer in the field whose production and development facilities are devoted exclusively to industrial, scientific and commercial photo-reproduction. The entire Peerless line of photocopy papers and machines is sold only through a network of factory distributors who are skilled photocopy specialists. Complete literature on all Peerless products is yours for the asking.

PEERLESS PHOTO PRODUCTS, INC.

Shoreham, Long Island, N.Y.

Manufacturers of Quality Photocopy Papers and Special-purpose Industrial Photocopy Equipment

154 ideas on ways to use...



154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own.

Moly-sulfide
A LITTLE DOES A LOT

The lubricant for extreme conditions

Climax Molybdenum Company
500 Fifth Avenue
New York City 36 N Y

Please send me your Free Booklet on *Moly-sulfide*

Name.....
Position.....
Company.....
Address.....

MOLY

P.E.-10 MS-6A

LIKE PRACTICAL (and pleasant) COMPARISONS?

FREDDY FEDERAL SAYS:

... in any shape or size up to 9" x 12" ... up to 3/16" thick.

... in any quantity from 2 pieces to 10,000

... from any stampable material
(metal • fibre • plastics)

TRY US Send us a print of the stamping you want fabricated and the quantity you need ... we'll send you an attractive figure without any obligation. This kid says: "We can please you."
"P.S. Write for Bulletins!"

Federal TOOL AND MANUFACTURING CO.
3620 ALABAMA AVE. ST. LOUIS PARK
MINNEAPOLIS, MINNESOTA
"QUALITY STAMPINGS IN SMALL QUANTITIES"

Speeding X-Ray Photography

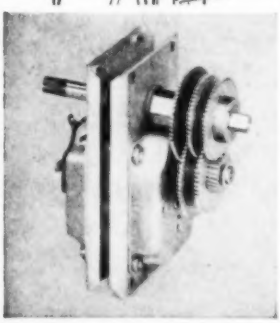
with

EEPCO-DESIGNED MOTORS

Manufacturing X-Ray equipment calls for precision and dependability in every part.

That's why, when the nation's three leading manufacturers of X-Ray machines chose the motor that moves the delicate negative holders, they selected motors designed and built by EEPCO.

These tiny motors of 1/500 h.p. (intermittent service) provide the reliable, steady source of power that revolves the negative changing mechanism. After a photo is made, the exposed negative with its lens and shutter, are automatically moved aside and a new unit moved into the ready position. Handling this task demands an even, slow application of power to avoid damage to the delicate mechanism. This is typical of the many unusual applications to which EEPCO-designed motors have been put.



Write today for complete details and catalog information

If your particular problem calls for special design, or merely for standard motors that can handle the toughest service, you'll find that EEPCO is the source on which to depend. Out of the many unusual requirements filled by EEPCO engineers has come experience unsurpassed in industry and always at your disposal.

Equally important, the EEPCO plant is well-equipped and staffed to turn out motors for you on a mass-production, low-cost basis when necessary.

EEPCO *ELECTRO ENGINEERING PRODUCTS CO.*
609 W. LAKE STREET, CHICAGO 6, ILLINOIS

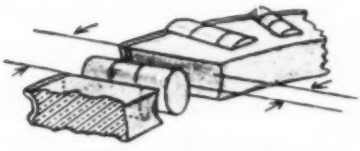
• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
• DC MOTORS & GENERATORS • SHADED POLE MOTORS (2-4-6 Pole) • P-M AC GENERATORS

Why Rollway's Right-Angle Design increases

BEARING RELIABILITY

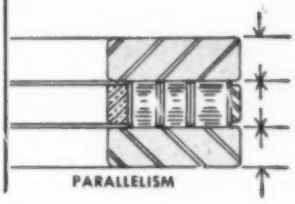
In a Rollway Thrust Bearing the rollers are precision machined to uniform cross-section . . . thrust plates are held to extremely close limits of parallelism. As a result, there's no skewing effect, no wedging of the rollers. Wearback of roller ends is held to a minimum.

That's why, in any given dimensional limit, Rollway Thrust Bearings give you more efficient, heavy-duty service and increased bearing life.



PARALLELISM

Accurate parallelism between the rollers and the matched thrust plates is repeated in the parallelism between the separator slots and the rollers themselves—all adding up to quiet, smooth rolling.



PARALLELISM

Our engineers are available without cost or obligation to assist you in selecting the correct Rollway Bearing for your needs. Contact your nearest Rollway sales office.

Rollway Bearing Company, Inc., Syracuse 4, N. Y.

SALES OFFICES

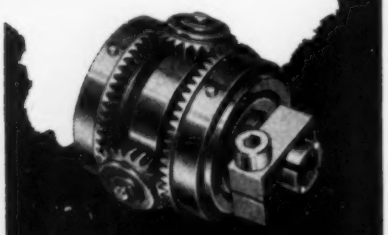
Syracuse, Cleveland, Pittsburgh, Boston, Philadelphia, Toronto, Los Angeles, Houston, Chicago, Milwaukee, Detroit

ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

Hollow Shaft Differential

Minimum weight, inertia, and backlash. A precision computer component. Designed for accurate resolution of angular position or velocity sums and differences. Hollow shaft design offers complete freedom of positioning of differential on shaft and facilitates installation-removal of differential from shaft without instrument disassembly. Shrink-on, safety-keyed side gears available to your specifications. Inertia: .0745 ounce-inch^2; maximum backlash: 10′; overall axial length: 1$^3/_{16}$″; clearance radius: .520″; weight: 1¼ ounces; unit receives a $^3/_{16}$″ diameter shaft. Precision ball bearings.



application versatility
in
computer components
by

LIBRASCOPE INCORPORATED

The functional solution to your computing and controlling problem is available at Librascope, where design simplicity keynotes 15 years of leadership in industrial control.

For details on this and other computing-controlling components, write:

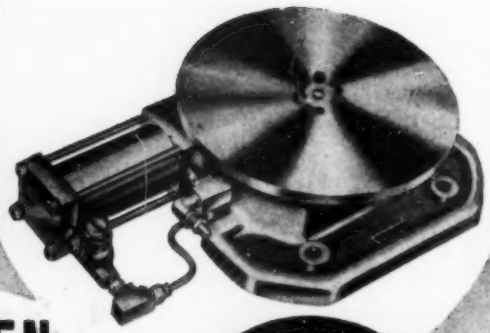
LIBRASCOPE, INC.

Mechanical and electrical analog computers, digital computers, input-output devices and components.

1607 FLOWER STREET, GLENDALE, CALIF.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

NEW



ALLEN DIAL FEED TABLES

with REVOLUTIONARY *POSITIVE LOCK FEATURE*

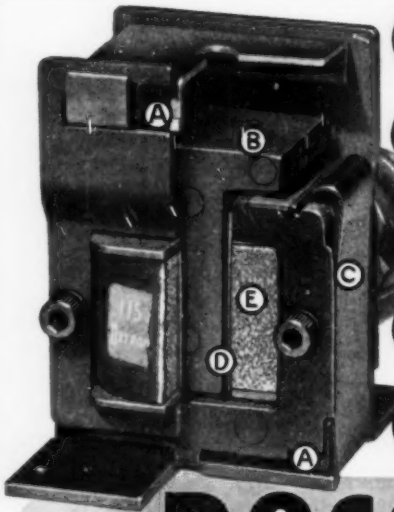
MODEL 11FA AND MODEL 11FB

- Top Plate Guaranteed Against Over-ride.
- Anti-back-up Pawl Locks Table Against Rearward Motion.
- Hydraulic Check Available for Extra Smooth Operation.
- Adjustable from 4 to 24 Index.
- Working Parts Flame Hardened, Completely Enclosed.

PLEASE WRITE FOR ILLUSTRATED BROCHURE

THE A. K. ALLEN CO.
57 MESEROLE AVE. • BROOKLYN 22, N. Y.
For Export: States Trading Co., 401 Broadway, New York, N.Y.
Cable Address: Stradeo, N. Y.

AGENTS IN PRINCIPAL CITIES



A Shock-absorbing bumpers cushion stroke, assure longer service life.

B Silicon steel laminations give high efficiency.

C Tempered steel spring absorbs vibration — holds assembly firmly in alignment.

D Hardened beryllium-copper plunger guide reduces friction and wear.

E Heavy Formvar insulated magnet wire on high flow point molded nylon bobbin.

Decco INDUSTRIAL SOLENOIDS

Built better for longer service.
Shock mounted to reduce self-destruction.
Designed to meet J. I. C. specifications.
Four to twenty pounds—push or pull.
Stroke to one inch maximum.
A. C. or D. C. models.

Special solenoid problems engineered to your needs.

DETROIT COIL COMPANY
2435 HILTON ROAD • DETROIT 20, (FERNDALE) MICHIGAN

℞: BERYLLIUM COPPER

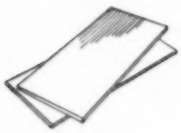
Beryllium Copper (BeCu in metallurgical shorthand) is a leader in the "resistance movement." It's uncanny the influence a few per cent of Beryllium can exert on pure copper . . . the added properties the *alloy* has over the base metal *alone.*

Beryllium Copper can be hardened by heat-treatment. It has high electrical conductivity and qualities that resist wear, corrosion and fatigue, making it ideal for switches and other electrical applications. BeCu is truly a versatile alloy, useful in many fields.

Riverside *Alloys* are Industry's *Allies.* Send for the Riverside Handbook, the pocket-size reference and guide to alloy specifications. The Riverside Metal Company, Riverside, N. J. Branches in all principal cities.

RIVERSIDE ALLOYS

PHOSPHOR BRONZE • NICKEL SILVER
CUPRO NICKEL • BERYLLIUM COPPER


SHEET

STRIP

ROD

WIRE

Free pocket-size Alloy Handbook. Your reference and guide to Alloy specifications. Write today.

"144,000 of our employees are enrolled in the Payroll Savings Plan"

C. F. HOOD
President, United States Steel Corporation

"The response of our employees to the Payroll Savings Plan for U. S. Savings Bonds is dramatic evidence of their conviction that Freedom is Everybody's Job. We are proud of their outstanding record in saving systematically in "E" Bonds, in thus adding to their financial independence as they give effective support to the nation."

Mr. Hood and his associates may well be proud of the Steel Corporation's Payroll Savings figures:

- 144,000 men and women of U. S. Steel are enrolled in the Payroll Savings Plan—an over-all employee participation of 52%—excellent for a company as large as U. S. Steel.
- the average monthly investment of a U. S. Steel Payroll Saver is $20.79.
- every month, these 144,000 employees invest $2,993,760 in personal security—and America's economic stability.
- in some U. S. Steel plants and subsidiaries employee participation runs as high as 80%.

Nearly eight million men and women, in forty-five thousand companies, large and small, are building personal security and contributing to national economic stability by their $160,000,000 monthly investment in U. S. Savings Bonds. These Payroll Savers, with their $25 and $50 Bonds, are major shareholders in a huge reservoir of future purchasing power—the $35.5 billion, *cash value* of Series E Bonds outstanding.

What is the employee participation in *your* Payroll Savings Plan? The average monthly deduction? How many employees have been *added* to your Payroll Savings Plan in the last year? Call for the figures and study them. Then, phone, wire or write to Savings Bond Division, U. S. Treasury Department, Washington Building, Washington, D. C. Your State Director will be glad to show you how easy it is to raise employee participation in your plan to 60%, 70%, or even better.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

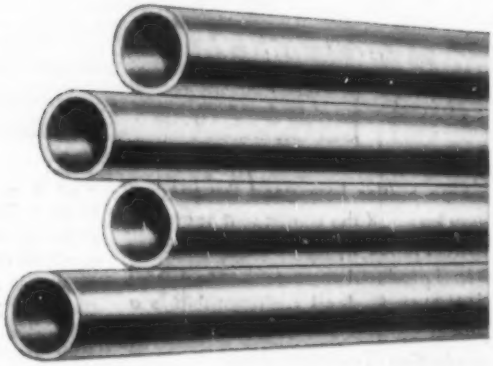
Product Engineering

You're sure of UNIFORM HIGH QUALITY

SEAMLESS • PRESSURE • MECHANICAL

CARBON STEEL TUBES

when you specify GLOBE



SIZE RANGE — WALL THICKNESS

Globe seamless carbon steel tubes are available in a size range of ½ inch to 7½ inches O.D.; wall thickness of .028 to 1.000 inch.

APPLICATIONS

Globe Pressure Tubes are used for boilers, condensers, heat exchangers and process equipment. They meet most exacting demands of modern high pressure and high temperature installations. Globe Mechanical Tubing (seamless) is produced by piercing solid billets. It is an ideal material for low-bearing structural members and parts where strength with minimum weight is needed. Its economy for the manufacturing of many machine parts is universally recognized.

Globe seamless carbon steel tubes are furnished to standard specifications in low and medium carbon ranges.

WHEN you specify Globe you are sure of uniform high quality carbon steel tubes. That's because they are the product of highly developed production facilities and specialized quality controls and methods.

Globe engineers are at your service to assist in the selection of tubing of the exact characteristics you require.

GLOBE TUBES

GLOBE

STEEL TUBES CO.

MILWAUKEE 46, WISCONSIN

Chicago • Cleveland • Philadelphia • St. Louis • New York • Detroit • Denver • Houston • San Francisco
Glendale, Calif.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy-carbon seamless steel tubes — Globeiron (high purity ingot-iron) seamless tubes — Globe welding fittings.

Typical example of a precision, custom-made gear by Perkins

Across the Nation

on countless products

you'll find the "imprint"

of Perkins custom-made Gears!

for no matter how good the product may be . . . if the component gears are custom-made by PERKINS it will be a *better* product. Long experience coupled with New England craftsmanship is a potent and hard-to-beat factor in the production of precision gears.

You Furnish the Specifications
We'll Produce the Gears

PERKINS MAKES:
to customers' specifications, in all materials, metallic and non-metallic: bevel gears, ratchets, sprockets, ground thread worms, spiral gears, helical gears, spur gears with shaved or ground teeth. Have us quote on your requirements.

✻ A new product is the **PERKINS PRECISION SPRING COILER.** This coiler (patent applied for) turns out precision springs—any type, shape, size from wire sizes .005 to .125. Complete data and prices upon request.

✻ Another new product — the **PERKINS "BENDIT 15"** — a patented metal forming machine which bends and shapes sheets, rods; strips tubing into innumerable complex as well as simple forms that would be difficult or even impossible to make by other means. Eliminates need for expensive tools or specialized skills. Height 47", net weight 200 lbs. Write us today for descriptive catalog, prices, etc.

PERKINS MACHINE & GEAR CO.

WEST SPRINGFIELD, MASSACHUSETTS

Is there any data available on elastic elongation of chains?

Actually, until very recently there has been little or no data available to designers regarding elastic elongation of various types of chains. A report in your *Annual HANDBOOK of Product Design for 1953*, however, for the first time outlines and shows in table and graph form the results of extensive tests to determine accurately the average elastic elongation of single strand ASA roller chain, double pitch conveyor chain, and cable chain.

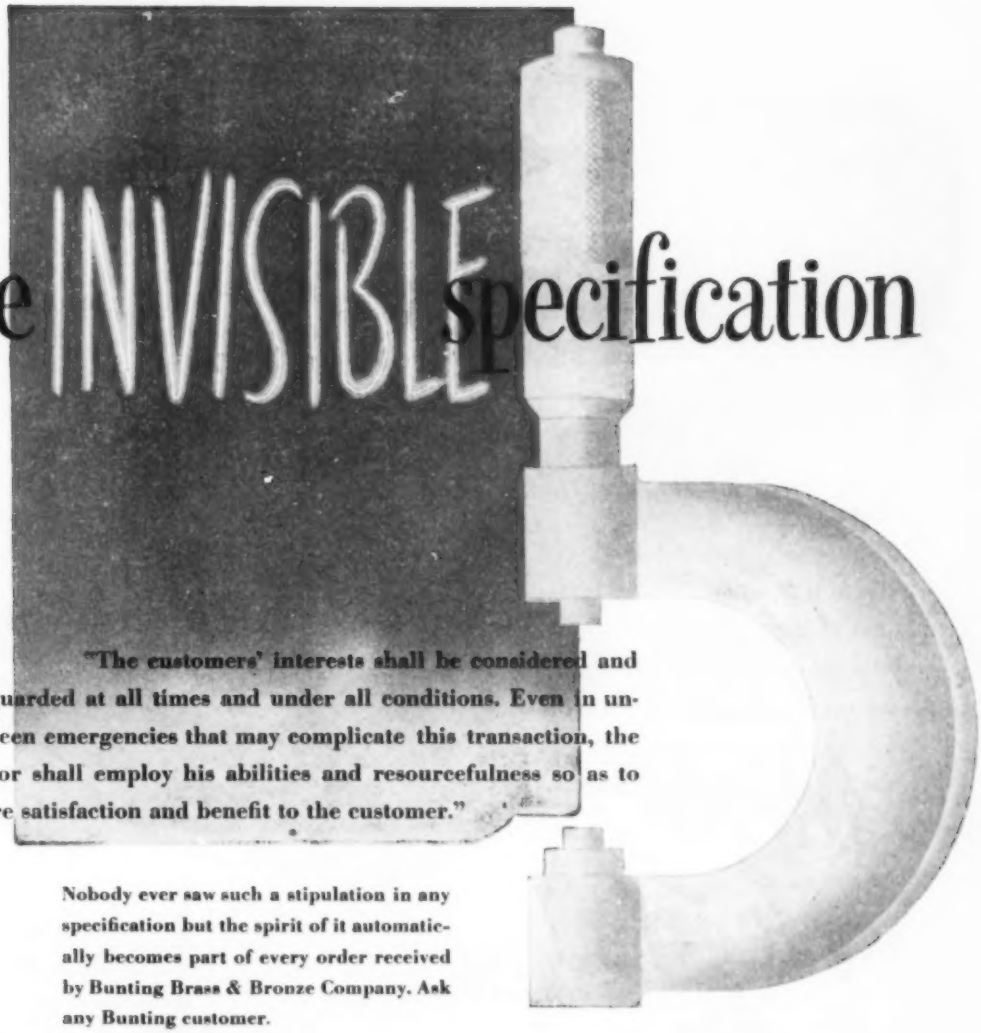
The *HANDBOOK*, published for the first time last November, has earned the acclaim of design engineers everywhere for its abundance of up-to-the-minute and lastingly useful product engineering data. All the vital information in the *HANDBOOK* is separated into ten major classifications and fully indexed so that you can easily find exactly the data you particularly want. For example, the report mentioned above, titled "Elastic Elongation of Chains," is found in the section on *Power Transmission*.

Another edition will be along to join your '53 *HANDBOOK* in November. *The Annual HANDBOOK of Product Design for 1954* will present an even broader, more informative selection of data important to you in your work. Again, you'll receive the *HANDBOOK* with your regular subscription to *Product Engineering*, at no extra cost.

Product Engineering

330 West 42nd Street
New York 36, N. Y.

the INVISIBLE specification



"The customers' interests shall be considered and safeguarded at all times and under all conditions. Even in unforeseen emergencies that may complicate this transaction, the vendor shall employ his abilities and resourcefulness so as to insure satisfaction and benefit to the customer."

Nobody ever saw such a stipulation in any specification but the spirit of it automatically becomes part of every order received by Bunting Brass & Bronze Company. Ask any Bunting customer.

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

Bunting®

BRONZE BEARINGS • PRECISION BRONZE BARS • BUSHINGS

THE BUNTING BRASS & BRONZE COMPANY • TOLEDO 1, OHIO • BRANCHES IN PRINCIPAL CITIES

"He Might Need It..."

"He never was much for letter-writing when he was in college. But he must know how anxious Mother and I are . . . now that he's off in Korea. Haven't heard from him in six weeks. Of course, they say 'no news is good news' . . . but I wonder. Maybe he can't write . . . because . . . maybe he's in a hospital somewhere. And maybe he needs blood. I don't know . . . but I'm not taking any chances. That's why *I'm* giving blood."

★ ★ ★

Yes, all kinds of people give blood —for all kinds of reasons. But whatever *your* reason, this you can be sure of: Whether your blood goes to a combat area, a local hospital, or for Civil Defense needs— this priceless, painless gift will some day save an American life!

Give Blood Now

CALL YOUR RED CROSS TODAY!

NATIONAL BLOOD PROGRAM

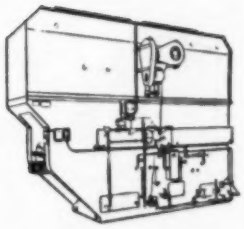
Business Executives!

✓Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
- ☐ Has your company given any recognition to donors?
- ☐ Do you have a Blood Donor Honor Roll in your company?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed employees of your company's plan of cooperation?
- ☐ Was information given through Plant Bulletin or House Magazine?
- ☐ Have you conducted a Donor Pledge Campaign in your company?
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?

Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*



DEGREASING MACHINE

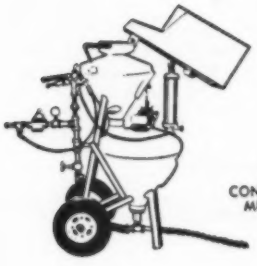
what are your VALVE NEEDS?

AIR VISE

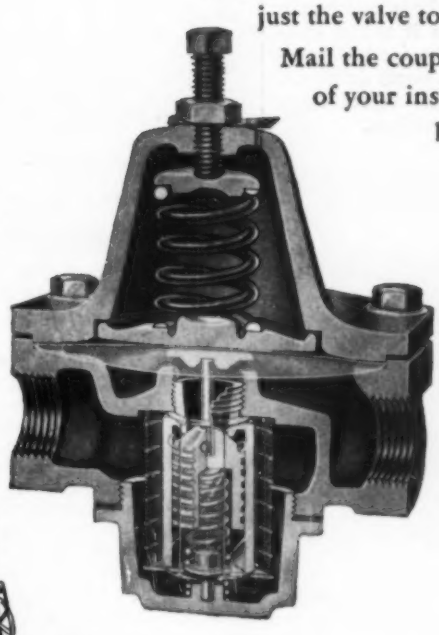
Do you have a space limitation to deal with before you select a valve? Is delivery of the automatic valves you're now using slowing down production?

If you have a pressure control valve need, here's how to fill it. The answer lies in a CASH-ACME valve . . . Or with CASH-ACME's staff of engineers who will develop just the valve to do the job you have in mind.

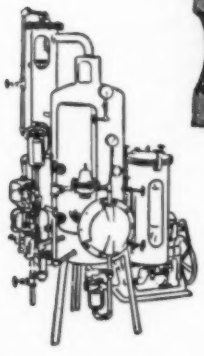
Mail the coupon below with a brief outline of your installation requirements. A free booklet or catalog on request.



CONCRETE MIXER



cash-acme has the ANSWER!



STEAM EQUIPMENT

CASH ACME

SILENT SENTINEL *Automatic Valves*

A. W. CASH VALVE MFG. CORP.
6662 E. WABASH AVENUE • DECATUR, ILLINOIS

ATTACH TO YOUR LETTERHEAD

A. W. Cash Valve Mfg. Corp.
6662 E. Wabash Avenue
Decatur, Illinois

☐ Please send me your free booklet.

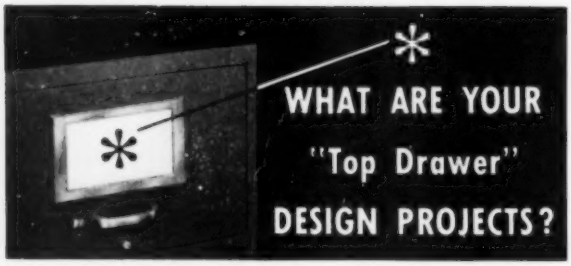
NAME_____

FIRM_____

ADDRESS_____

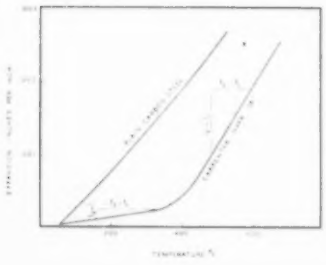
CITY_____ STATE_____

To save time may we suggest a brief outline of your requirements be mailed with this coupon.



Carpenter *Free-Cut Invar "36"* may improve them . . . ease fabrication . . . sharpen the sales edge on your product.

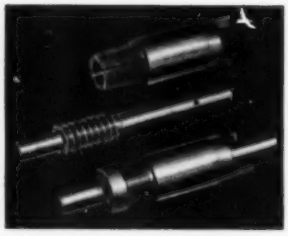
PRACTICALLY NO THERMAL EXPANSION



When used from room temperature up to 400°F, *Free-Cut Invar "36"* has a thermal expansion of 1/10 that of carbon steel. This fact alone makes it worth considering for high precision parts demanding extreme accuracy in operation.

ELIMINATES MACHINING PROBLEMS

No longer are invar's valuable low expansion characteristics handicapped by machining difficulties. *Free-Cut Invar "36"*—an exclusive Carpenter development has solved the problem; opened new fields for its use through easier fabrication.



GET THE COMPLETE DETAILS

For complete information on Carpenter *Free-Cut Invar "36"* . . . how you may profit from its low expansion properties, and easy fabrication—write today for your copy of the Carpenter Low Expansion Alloy Book. In it are valuable facts and information to help in your product planning.

THE CARPENTER STEEL COMPANY
117 W. Bern Street, Reading, Pa.
Export Department: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

Carpenter

HIGH NICKEL ALLOYS

offer you new opportunities to design better products.

SKINNER
Solenoid Valves
for air & hydraulic cylinders
fluid shut-off
diaphragm operated equipment
coolant control

M2 **BRONZE BODY**

"M" SERIES pilot-operated Skinner Valves have extremely fast action, and large capacity on air, inert gas and liquid applications. All internal metal parts are stainless steel or brass. Soft seals prevent leakage — operate in any position — rubber coated, nylon fabric diaphragm for long life — port size ½" or ⅜", orifice ⅜" — power consumption, 10 watts — continuous duty.

M2 is two-way, normally closed, 5 to 150 p. s. i., weight 3 lbs. **M3** is three-way, normally closed, normally open, or directional flow, 20 to 150 p.s.i., weight 3¾ lbs.

M3

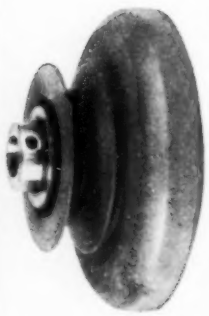
Write for Bulletins No. 493 & 494

Skinner **ELECTRIC VALVE DIV.**
THE SKINNER CHUCK COMPANY
114 Edgewood Avenue, New Britain, Connecticut

ABSOLUTELY!

"Mercury" is the *only* clutch utilizing hydraulic pressure produced by the effect of centrifugal force on liquid mercury. For that reason it gives automatic controlled application of torque to the driven load. Its high starting torque eliminates "overpowering"; pick-up is smooth without grab or chatter, and less starting current is required. In short, it is possible to achieve efficiency and economy with a general purpose motor coupled with a Mercury Clutch.

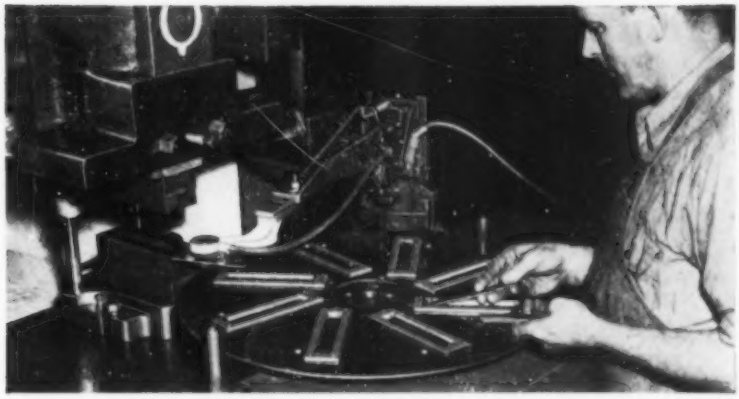
Whether your equipment is electric or gas driven, it will pay you to put your clutch problems up to Mercury's engineers, *Mercury Clutch Division*, **AUTOMATIC STEEL PRODUCTS, INC., CANTON 6, OHIO.**



MERCURY CLUTCHES

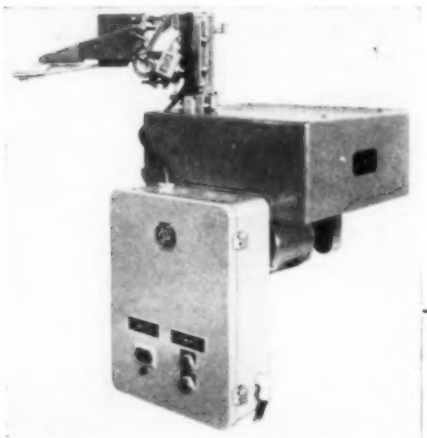
Clutch Problems?
MERCURY HAS THE ANSWER!

When reaching into a dangerous place your hand might make an error. The Feed-O-Matic will not.



the way your hand and arm would move

The Feed-O-Matic can match the rhythm of a punch press or of any machine that has rhythm.



The Feed-O-Matic is adaptable. For example, nests can be multiple or single in accordance with the sizes and types of parts to be handled.

If you had to lift a small article and place it accurately in the correct position, and had to be alert against letting a machine operate if the placing was not completely right, and you had to repeat that operation with rhythmic precision all day and perhaps all night, then your hand and arm would move exactly the way the arm of the V & O Feed-O-Matic moves.

You would not work with the invariable precision of the Feed-O-Matic, of course. Nothing human could do that. You would make dangerous mistakes that the Feed-O-Matic never makes when you reach into dangerous places. You would let your attention wander and would forget, as the Feed-O-Matic cannot forget, to prevent the machine from acting if you mis-positioned a part. But as long as you managed to keep going your hand and arm would use the same motions that the Feed-O-Matic uses.

This "natural" rhythmic motion makes the Feed-O-Matic easy to understand and apply. It governs the operating rhythm of a punch press and can govern any similar machines. It can supply its own rhythm to space objects evenly along a conveyor belt or other materials handling device.

You can make the feeding of dangerous machines completely safe. You can use high cost tools that you never would dare to expose to human fallibility.

Your plant has plenty of uses for Feed-O-Matics. The full story is yours for the asking. An engineer who can tell you all about it is right in your neighborhood. Write us.

Only the best is good enough

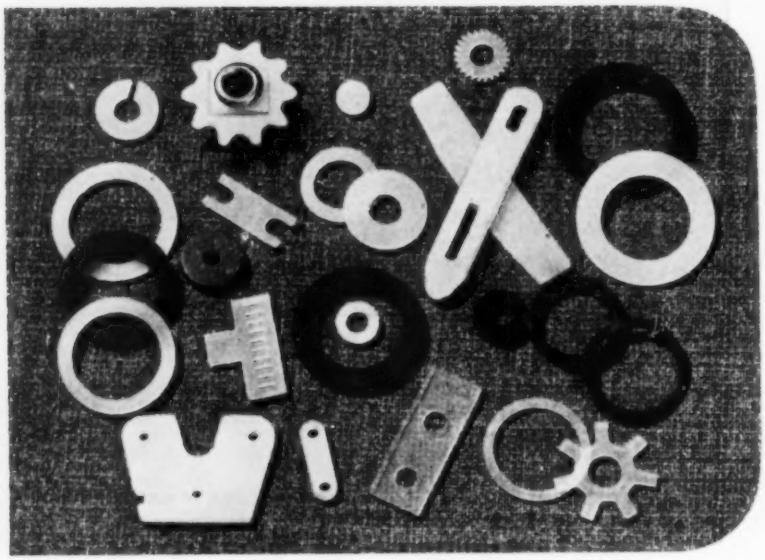
THE V&O PRESS COMPANY

DIVISION OF EMHART MFG. CO.

HUDSON, NEW YORK

Builders of Precision Power Presses and Feeds Since 1889

REDUCE THE COST OF NYLON PARTS



...BY BLANKING THEM FROM

POLYPENCO® NYLON STRIP

A wide variety of nylon parts can be blanked from POLYPENCO strip. Standard metal-working punch presses and feeding methods are used. In addition, production rates can be as high as 600 pieces per minute for lower unit costs. Standard strip sizes permit parts as thick as .125" and as wide as 4".

Use of POLYPENCO nylon strip eliminates costly delays in tooling and practically eliminates tooling cost. You get assurance of uniform high quality output, too. Every coil of stock undergoes rigid tests for constant properties and uniform dimensional tolerances.

Write today for sample parts blanked from POLYPENCO strip. A new 4-page bulletin on POLYPENCO nylon and other non-metallics is also available upon request.

POLYPENCO NYLON

**nylon and teflon*
other non-metallics / *stock shapes, finished parts*
*also available to your specifications***

The POLYMER CORPORATION of Penna. • Reading, Penna.

*trademark for Du Pont tetrafluoroethylene resin

There's a girl in our office...

... Whose one job is to expedite delivery of your requests for "New Catalogs and Bulletins" to the manufacturers concerned.

The job keeps her busy, too. She handles several thousand requests from Product Engineering readers every month. And she's anxious to be of service to you whenever she can.

So check the "New Catalogs and Bulletins" insert if you haven't already done so. You'll find a lot of useful information listed there ... and any of it is available to you promptly and without cost.

Product Engineering

SELF-LOCKING "PLACE" BOLTS

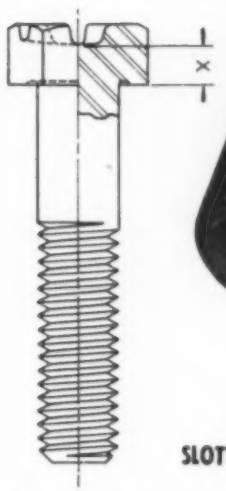
...cut costs...add strength

. . . wherever involuntary loosening or fatigue are a problem!

In some typical automotive and farm equipment applications, for instance, "Place" Bolts are being used as connecting rod bolts, main bearing cap screws, and flywheel bolts.

Here, and wherever a locking bolt may be needed, the Slotted-Type "Place" Bolt offers not only positive locking action but economy and additional strength. It cuts costs because no additional parts or operations are needed. It adds strength because its controlled spring action guards against impact, shock and fatigue failures.

National makes the Slotted-Type "Place" Bolt in carbon or alloy steel, in any of a wide range of sizes. Write us for additional information, including our illustrated folder.



HERE'S HOW SLOTTED-TYPE HEAD LOCKS

The flexible diaphragm formed between slotted segments in the upper face of bolt head and circular recess adjacent to the shank in lower face (section X) acts as controlled spring element when head is properly wrenched against a rigid seat. Diaphragm is reinforced by the continuous-grained segment cold formed between upset slots in upper face.

U. S. Patent No. 2543705

THE NATIONAL SCREW & MFG. COMPANY

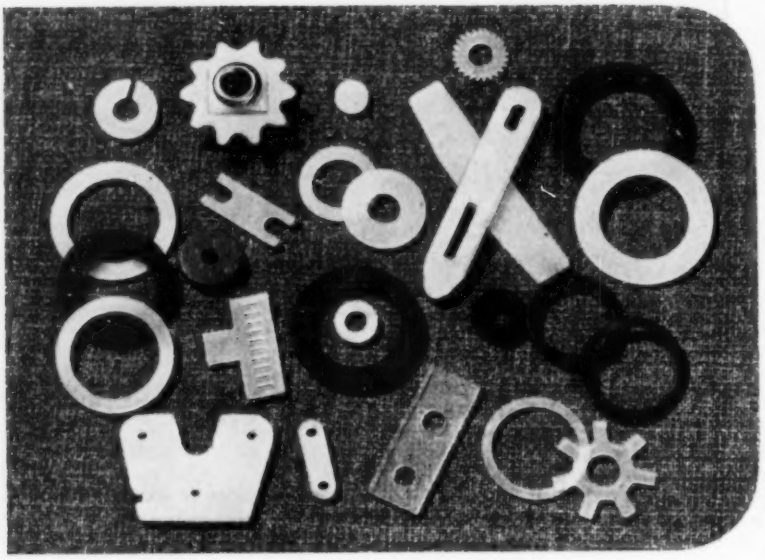
Cleveland 4, Ohio

Pacific Coast: **National Screw & Mfg. Co. of Cal.**
3423 South Garfield Ave., Los Angeles 23, Cal.

National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS

REDUCE THE COST OF NYLON PARTS



...BY BLANKING THEM FROM

POLYPENCO NYLON STRIP

A wide variety of nylon parts can be blanked from POLYPENCO strip. Standard metal-working punch presses and feeding methods are used. In addition, production rates can be as high as 600 pieces per minute for lower unit costs. Standard strip sizes permit parts as thick as .125" and as wide as 4".

Use of POLYPENCO nylon strip eliminates costly delays in tooling and practically eliminates tooling cost. You get assurance of uniform high quality output, too. Every coil of stock undergoes rigid tests for constant properties and uniform dimensional tolerances.

Write today for sample parts blanked from POLYPENCO strip. A new 4-page bulletin on POLYPENCO nylon and other non-metallics is also available upon request.

POLYPENCO NYLON

nylon and teflon* / other non-metallics / *stock shapes, finished parts*

also available to your specifications

The POLYMER CORPORATION of Penna. • Reading, Penna.

**trademark for Du Pont tetrafluoroethylene resin*

There's a girl in our office...

... Whose one job is to expedite delivery of your requests for "New Catalogs and Bulletins" to the manufacturers concerned.

The job keeps her busy, too. She handles several thousand requests from **Product Engineering** readers every month. And she's anxious to be of service to you whenever she can.

So check the "New Catalogs and Bulletins" insert if you haven't already done so. You'll find a lot of useful information listed there ... and any of it is available to you promptly and without cost.

Product Engineering

SELF-LOCKING "PLACE" BOLTS

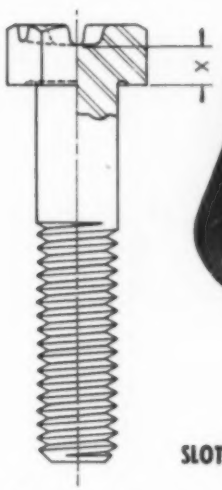
...cut costs...add strength

. . . wherever involuntary loosening or fatigue are a problem!

In some typical automotive and farm equipment applications, for instance, "Place" Bolts are being used as connecting rod bolts, main bearing cap screws, and flywheel bolts.

Here, and wherever a locking bolt may be needed, the Slotted-Type "Place" Bolt offers not only positive locking action but economy and additional strength. It cuts costs because no additional parts or operations are needed. It adds strength because its controlled spring action guards against impact, shock and fatigue failures.

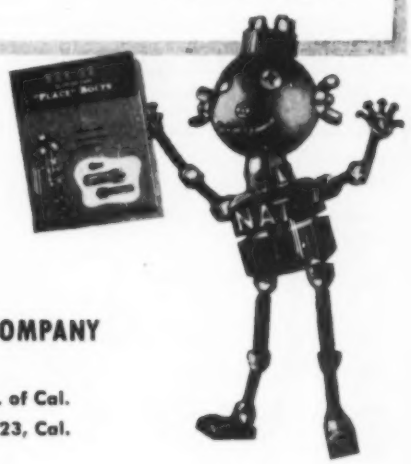
National makes the Slotted-Type "Place" Bolt in carbon or alloy steel, in any of a wide range of sizes. Write us for additional information, including our illustrated folder.



HERE'S HOW SLOTTED-TYPE HEAD LOCKS

The flexible diaphragm formed between slotted segments in the upper face of bolt head and circular recess adjacent to the shank in lower face (section X) acts as controlled spring element when head is properly wrenched against a rigid seat. Diaphragm is reinforced by the continuous-grained segment cold formed between upset slots in upper face.

U. S. Patent No. 2543705



THE NATIONAL SCREW & MFG. COMPANY

Cleveland 4, Ohio

Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 23, Cal.

National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS

SARAN RUBBER PARTS RESIST BOTH ACIDS AND SOLVENTS

They function as effective dual barriers to solvent and acid permeation to protect process equipment

Chemical equipment manufacturers are looking beyond the limitations of conventional elastomeric parts to solve complex corrosion problems. A typical case involves the rayon spin bath solution used by the rayon industry, containing sulfuric acid and carbon disulfide. Synthetic rubber parts exposed to conventional spin bath solutions usually suffer shortened work life. Parts swollen with carbon disulfide allow sulfuric acid to seep through and attack expensive spinning machine equipment. Many man hours are required to remove and replace the affected parts.

One large rayon manufacturer replaced synthetic rubber gaskets with saran rubber. This resulted in an increase of service life from three months to well over two years for each gasket. Specify saran rubber to your molder. We will be glad to assist him in the development and production of saran rubber mechanical goods for your specific requirements. For a free data booklet on saran rubber molded goods write to the SARAN LINED PIPE COMPANY, 2415 Burdette Avenue, Ferndale, Michigan.

RELATED PRODUCTS

Saran rubber tank linings — Saran lined steel pipe—corrosion-resistant pipe that gives long-term operation with minimum maintenance costs.

Saran Lined Pipe Company
2415 Burdette Avenue, Ferndale, Mich.

Please send me your data booklet on saran rubber.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

1509

SARAN LINED PIPE COMPANY

2415 BURDETTE AVENUE, FERNDALE, MICHIGAN

OFFICES IN NEW YORK • BOSTON • PITTSBURGH • TULSA • PHILADELPHIA • CHICAGO • PORTLAND
INDIANAPOLIS • SAN FRANCISCO • HOUSTON • DENVER • LOS ANGELES • SEATTLE • CLEVELAND
CHARLESTON, S. C. • TORONTO • MONTREAL

WHICH COATING for GRAY IRON?

8 pages — 25 cents a copy

Applications for gray iron in your products can be greatly expanded if surfaces of castings can meet a wide variety of finish specifications. Since gray iron is in many respects one of the most economical of base metals, careful consideration of applicable finishes is worthwhile.

This Special Editorial Report by Charles O. Burgess, Technical Director, Gray Iron Founders' Society, will serve as an invaluable guide for organic and chemical finishes for the manufacturers of gray iron products.

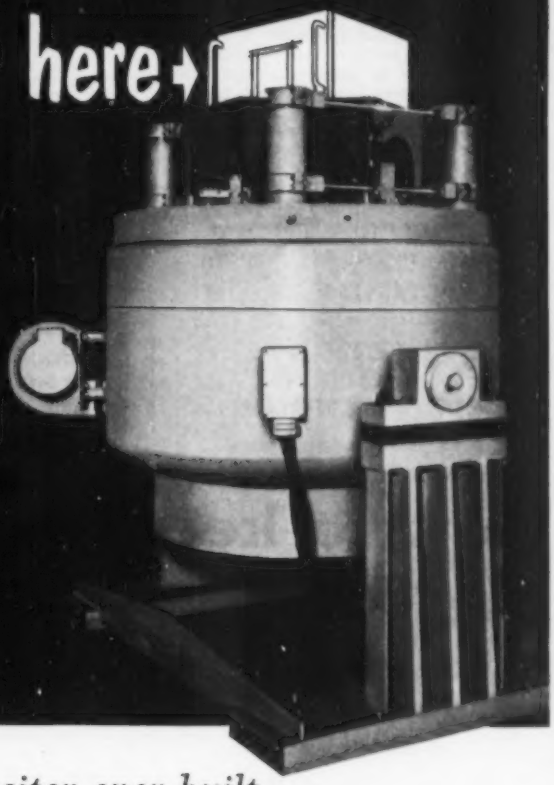
Copies of other reports in **Product Engineering's** series of full-color articles covering product improvement through better surface appearance and protection are also available. Write for an editorial reprint order form, listing titles and costs.

READER SERVICE DEPARTMENT

Product Engineering

McGraw-Hill Building,
New York 36, N. Y.

Put your product here → to shake-test it with 10,000 lbs force



MB produces the largest exciter ever built to meet heavy duty vibration test specifications

THERE's nothing like a good shaking to test out structural designs, electronic equipment, instruments or complete assemblies for faults or flaws. In fact, for many products put to military use, such tests are *specified*. However, since *all* products encounter some vibration or shock in service, many engineering departments use an MB Exciter to test all designs. By so doing, the "bugs" are discovered in the test laboratory instead of out in the field, at cost of good will.

Largest in the line of MB electromagnetic shakers, the Model C-100 shown delivers at least 5 tons continuous force. Its performance permits heavy duty vibration testing to MIL-E-5272 and other specifications. It incorporates a number of unusual design features for easy, quick, convenient operation—including interlocking controls for complete safety and provisions for cycling tests.

HOW TO HANDLE LARGE MASSES

MB can show you a setup of vibration exciter and resonating beam that multiplies the capacity of versatile MB Exciters many fold. Shaker being used in this fatigue strength test of aircraft engine mounts is the model S-3 rated at 200 lbs. Others available down to 10 lbs. force output.

Vibration is MB's specialty. You're invited to draw on the benefits of this specialization—and get highly qualified products for testing and control, and technical help on your problem.

Valuable bulletins for test engineers Calibrating vibration pickups to 2000 cps is comprehensively covered in MB Bulletin No. C-11-1. Bulletin No. 1-VE-1 describes vibration exciters and details their specifications. Write today.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION...TO MEASURE IT...TO ISOLATE IT

How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL FOR BUSINESS

McGRAW-HILL PUBLICATIONS

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE

$1.50 per line, minimum 3 lines. To figure advance payment, count 5 average words as a line.

(See ¶ on Box Numbers.)

POSITION WANTED & INDIVIDUAL SELLING OPPORTUNITY WANTED undisplayed advertising rate is one-half of above rate, payable in advance.

PROPOSALS $1.50 a line an insertion.

INFORMATION

BOX NUMBERS care publication count as 1 line additional in undisplayed advertisements. DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals.)

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style.

DISPLAYED RATES

The advertising rate is $12.60 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. P.E.

SEND NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42nd St., N. Y. 36, N. Y., for November issue closing October 20th

---

PRODUCT DESIGNERS AND DRAFTSMEN

Internationally prominent manufacturer of heavy machinery used in mining, crushing, cement and basic processing industries, located Midwest, has excellent opportunities for Mechanical Design Engineers and Draftsmen for research and development and new product design. Liberal employee benefits, plus exceptionally fine working conditions and opportunity for future. Write, stating experience, present employment, personal data and salary expected. Replies confidential.

P-8788, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

MECHANICAL ENGINEER

Excellent opportunity for a Graduate Mechanical Engineer with a manufacturing concern in Oklahoma City, Okla. The position is a permanent one in a growing organization and offers a real challenge to an ambitious man. At least 5 years' experience preferably in Tool Design some Drafting and Electrical experience required. All replies will be held in strict confidence. Interviews will be arranged. Write giving full particulars of education, experience, etc.

P-9278, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

PRODUCT WANTED

A product that will utilize the facilities of a machine shop with diversified equipment. Willing to purchase outright or manufacture on a royalty basis.

COLUMBUS ENGINEERING CO.
480 W. Broad St. Columbus 8, Ohio

AUTOMATIC WASHER CO.

NEWTON, IOWA

Positions now open for highest quality personnel. Liberal policies on vacation, insurance, etc. Specialized job training offered.

Junior Engineer, Mechanical. Graduate or man of equivalent mechanical understanding.

Design, Development Engineer, Mechanical. At least 5 years experience in engineering major home appliances or similar for quantity production. Must understand basic engineering and design, manufacturing operations, tolerances, finishes, etc. Electrical knowledge helpful. Age range 28 to 40.

Tool and Die Designer. Some direct machine, press shop or toolmaking experience. 2 years tool design experience. Part time on design board and part time on factory problems. Under 35.

Designing Draftsman, Mechanical. At least 5 years board experience on home appliances, farm equipment, or other light machinery for quantity production. Some engineering education desirable. Accurate and fairly complicated design layouts, analyzing tolerances and fits, and supervising and checking.

Write to
MR. W. C. BRUCKMAN
Vice President in Charge of Engineering

Cessna

ENGINEERING OPPORTUNITIES

with world's leading producer of light commercial airplanes

for

- Design Engineers
- Design Draftsmen
- Research Engineers

Send Resume to

CESSNA AIRCRAFT CO.
ENGINEERING PERSONNEL
WICHITA, KANSAS

DESIGN AND PRODUCT ENGINEER

25-32 years of age with three to five years' experience designing mechanisms or semi-automatic machinery. Will be responsible for design, development, construction, and testing machines to change manufacturing processes. Does not require knowledge of precision or high-speed equipment.

P-9068, Product Engineering
330 W. 42 St., New York 36, N. Y.

MACHINE DESIGNERS

Research and engineering division located outlying section of Los Angeles requires the services of three top men in the field of machine designing who have experience in paper converting equipment or other fully automatic precision machinery. Must be able to work with minimum supervision. This is a nation-wide multi-plant manufacturer of paper containers and can offer permanent position, pleasant working environment, to only exceptional men who qualify. Send us complete record of past experience, earnings and education.

P-8795, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

When Writing Your Ad

Provide an indexing or subject word. Write it as the first word of your ad. If it is a Position Wanted or Position Vacant ad, make the first word the kind of position sought or offered. The right is reserved to reject or revise all Want Advertisements.

Classified Advertising Division
PRODUCT ENGINEERING

WANTED
A DISTINCTIVE PRODUCT

Our client, an established New England manufacturer, wants to add one or more products selling through same channels as present line; will be interested in

1. Small machine tools, such as milling machines or tool grinders.
2. Accessories for machine tools, such as drill attachments, drill heads, dividing heads or adjustable angle plates.

Market acceptance established, sales potential $500,000 a year and up.
Please write referring to advertisement No. 57. Brokers protected.
We are compensated by our client.

WELLING & WOODARD, INCORPORATED
52 Vanderbilt Avenue New York 17, N. Y.
CONSULTANTS IN DIVERSIFICATION AND NEW PRODUCTS

ASSISTANT CHIEF DESIGNERS

READY FOR . . . . A CHANGE

If you feel that your present job does not offer you the future you are seeking—and you qualify—we are interested in you.

We have openings in our expanding Product Development Department for work on products in the major home appliance field—ranges, refrigerators, freezers and air-conditioning equipment.

- Well rounded board layout or design training and experience in any of the above products required. Principal assignments will be on new production models. Duties involve preparation of design and layout drawings, and some supervisory responsibilities related to design projects for mechanical equipment. Some checking of drawings for accuracy of detail and scaling.

- Compensation dependent upon experience and ability. Salary increases based on merit and initiative. Location is in Galesburg, Illinois—a community with a future. Submit complete resume to Mr. E. E. Aylor, stating experience, education, salary required and date available.

ADMIRAL CORPORATION

GALESBURG, ILLINOIS

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

OLD ESTABLISHED manufacturer of carbon, brushes, seal rings, etc., located in small community wishes to employ research and development engineer as Chief Engineer. Duties involve control of laboratory and supervision of all tests and development of new materials. Reply in detail stating salary expected. P-9288, Product Engineering.

EMPLOYMENT SERVICE

SALARIED PERSONNEL, $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. H, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

PRODUCT DESIGN Engineer 6 yrs desires position experience includes design through initial production consumer products. PW-9303, Product Engineering.

EXECUTIVE ENGINEER desires connection with medium size company to assume full responsibility as Production Manager, Chief Engineer or Staff Assistant. 25 years of unique practical, design, manufacturing and sales experience in the automatic machinery and precision instrument field. Thoroughly familiar with engineering and developing new products, cost conscious, capable organizer. Age 51. College Graduate ME. Present Salary $15,000.—plus bonus. West Coast Location preferred. PW-9126, Product Engineering.

BUSINESS OPPORTUNITY

Good automotive or industrial product to manufacture and sell. We have tool room and complete shop facilities. Send definite information and details to: BO-9284, Product Engineering.

CONTRACT WORK

At the Metal Show...

MEET US AT THE MOBILE

Booth #2515, Cleveland, Oct. 19 to 23. American Non-Gran Bronze Co., Berwyn, Pa.

NON-GRAN

THREADED Rods

10 to 12 ft. lengths
ALL METALS
Also Screw Machine Products to Order

EASTERN
Machine Screw Corp.
12-32 Barclay St.
New Haven, Conn.
Makers of H & G Die Heads

PROFESSIONAL SERVICES

GREEN AND SIMES
CONSULTING ENGINEERS—INDUSTRIAL SPECIALISTS
New products designed and developed
Present products redesigned for future markets
Manufacturing and administrative methods simplified
Hotel Marlemont Building Cincinnati 27, Ohio

GEORGE H. KENDALL
Consulting Mechanical Engineers
Methods Studies: Process or Product
Redesign Existing Products for Greater Profit, Trouble Shooting Production, Design, Cost Problems, Specialist Automatic Machinery, Process, Controls, New Developments, Patent Studies, Investigations, New Products & Process Engineering Studies
P. O. Box 3 (Est. 1923) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

NEW YORK TESTING LABORATORIES, INC.
CHEMICAL, MECHANICAL, ELECTRICAL METALLURGICAL ENGINEERS
ANALYTICAL CHEMISTS, PHYSICISTS, X-RAY
Analysis, Tests of all Materials and Products, Plant and Field Services in Special Measurements of Stress, Sound, Vibration and other. Consultants in Litigation and Process Engineering and Design
80 Washington St. New York City 6, N. Y.

SKINNER, HARLAN AND IRELAND, INC.
Consulting Engineers
Specializing in Magnetic Materials and Their Application
Office and Laboratory Indianapolis 7, Indiana

An Investment!

Productive advertising is an INVESTMENT rather than an EXPENDITURE.

"Searchlight" advertisers almost invariably report prompt and satisfactory results.

BE CONVINCED — send us your advertisement TODAY.

Address Classified Advertising Division

PRODUCT ENGINEERING
330 W. 42 St. New York 36, N. Y.

Index of

PRODUCTS ADVERTISED

In This Issue

•

MATERIALS

Adhesives 94
Aluminum Alloys...2, 36-37, 76-77 87, 325-326
Beryllium Alloys 304, 435
Bimetal 87, 381
Brass 2, 95, 366, 403
Brazing Alloys 259
Bronze 76-77, 95, 413
Carbide Alloys 376
Carbon 241
Carbon Graphite ...4th Cover, 241
Ceramics 111
Chemicals 8, 428
Copper Alloys....2, 76-77, 87, 95 381, 435
Cork Compositions 56-57, 71
Fabrics, Coated or Impregnated 412
Felt 402
Fibre 47, 255, 352
Friction Materials 18-19
Glass 352, 361
Jewels, Synthetic 430
Laminated Metals .....87, 260 Insert facing p. 288, 428
Leather .....2nd Cover
Lubricants 8, 280, 404
Magnesium Alloys 81
Manganese Alloys 87
Molybdenum Alloys 432
Nickel Alloys 66, 400, 435
Nylon 16, 422
Optical 451
Paper 47, 319, 356
Phosphor Bronze 435
Plastics 6, 16, 73, 92, 210, 268 301, 307, 322, 338, 420, 456
Plastics, Laminated 301, 375 379, 387
Platinum Alloys 87
Powdered Metals.....4th Cover 241, 281
Resins 47, 319, 356
Rubber & Synthetics...2nd Cover 15, 242, 268, 322, 324, 422, 446
Silicones ..Insert between pp 324 & 325
Silver Alloys 87, 435
Stainless Steel..212, Insert facing p. 320, 400, 437
Steel .....65, 72, 212, 261 Insert facing p. 288, 299
Tool Steel 376
Zinc 12

STRUCTURAL PARTS

Bars 366, 400, 439
Bushings 439
Castings..10, 66, 245, 257, 267, 305 321, 371, 407, 410, 415, 423, 426
Die Castings 46, 62, 344, 428
Expanded Metals 253
Extrusions 322, 420
Forgings ...300, 306, 346, 348, 384
Metal Powder Parts....4th Cover 18-19, 241, 381
Rods 2, 366, 435, 444
Shapes 6, 322, 369
Sheets .....Insert facing p. 320 324, 435
Stampings 351, 432
Strips....117, Insert facing p. 288 Insert facing p. 320, 435, 444
Tubing..47 58, 70, 90, 96, 239, 243 250, 261, 302, 322, 339 353, 437, 444
Weldments 283
Wire 295, 435

FINISHES

Non-Metallic..83, 84, 266, 316-317
Paints & Lacquers.....266, 345
Plating 263
Rust Proofing.....8, 263, 266, 416
Sealants 458

MECHANICAL PARTS

Abrasives 18-19
Adhesives 94

(Continued on Page 452)

TO HELP YOU SPECIFY

the world's finest optical parts for your design

Order with confidence... from a catalog stock of lenses, prisms, reflectors and other optical parts, made to the highest precision standards of the optical industry.

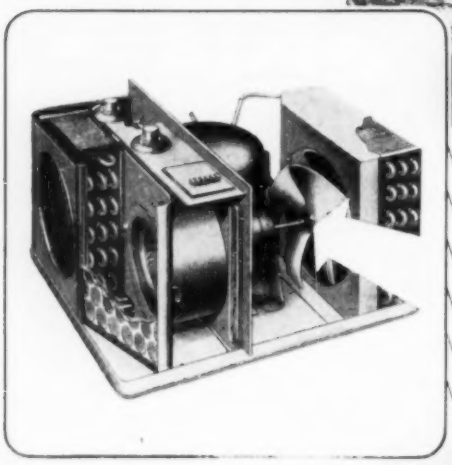
- Plano-Convex Lenses (Centered)
- Double-Convex Lenses
- Double-Concave Lenses
- Plano-Cylinder Lenses
- Positive Meniscus Lenses
- Negative Meniscus Lenses
- Projection Condensers
- Achromatic Lenses
- Crown Glass Wedge Type Prisms
- Equilateral 60° Prisms
- Right Angle Prisms
- First Surface Reflectors —Plane
- Second Surface Reflectors —Plane
- Second Surface Reflectors —Concave Spherical
- Parabolic Reflectors
- Cylindrical Strip Lenses
- Ground Glasses
- Heat Absorbing Glass
- Retardation Plates

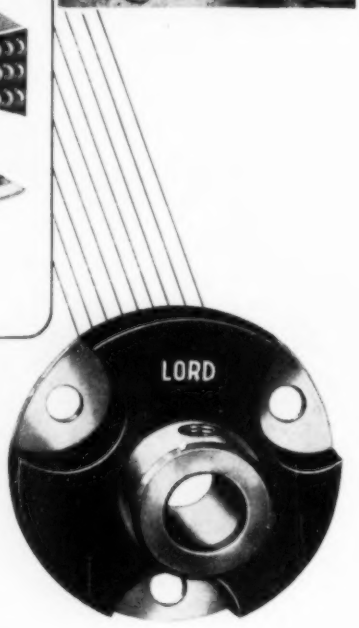
1853 1953 INTO A NEW CENTURY OF OPTICAL PROGRESS
BAUSCH & LOMB CENTENNIAL

WRITE for catalog, and for information on special orders. Bausch & Lomb Optical Co., 66822 St. Paul St., Rochester 2, N. Y.

BAUSCH & LOMB
Optical Parts

LORD
BONDED-RUBBER *Fan Hub*





for Quiet Operation of

fedders

A GREAT NAME IN COMFORT

ROOM AIR CONDITIONER

THE fans of the famous Fedders Room Air Conditioner are equipped with the Lord Bonded-Rubber fan hub shown here. It forms an effective "sound dam" between shaft and fan. With no metallic path for vibration to follow, noises from shaft or components never reach the room in which this Fedders unit is installed. Lord Vibration and Shock Control Mountings and Bonded-Rubber components are in use by leading appliance manufacturers to improve product performance and increase customer satisfaction and comfort. We shall be pleased to work with you on the operational improvement of your products.

BURBANK, CALIFORNIA — 233 South Third Street
DALLAS, TEXAS — 413 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA — 725 Widener Building
DAYTON 2, OHIO — 410 West First Street
DETROIT 2, MICHIGAN — 311 Curtis Building
NEW YORK 16, NEW YORK — 280 Madison Avenue
CHICAGO 11, ILLINOIS — 520 N. Michigan Ave.
CLEVELAND 15, OHIO — Room 811 Hanna Building

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER — *Headquarters for* VIBRATION CONTROL

Index of PRODUCTS ADVERTISED In This Issue

•

(Continued from Page 451)

Axles 264, 386
Balls 262, 332
Bearing, Ball, Roller & Needle..28-29, 39, 42, 55, 74-75, 78 98-99, 102, 114-115, 128, 225, 227 233, 273, 293, 310, 362, 384 393, 433
Bearings, "Oil-less" .....4th Cover
Bearings, Sleeve .....4th Cover 381, 413, 439
Bellows 110, 124
Belts ...15, 18-19, 34, 247, 372, 424
Bolts, Nuts, Screws & Rivets 32 40-41, 51, 54, 79, 103, 120, 276 312-313, 328, 354, 365, 388, 399 417, 445
Blowers 392
Brakes 297
Bushings & Grommets.....340, 381
Cameras 336
Chains 11, 44-45, 67, 286
Clamps 289
Clutches 297, 333, 336, 384 392, 442
Containers 424
Controls, Insert facing..p. 289, 308 360, 377, 382, 420
Counters 17, 348
Couplings, Flexible ...14, 235, 248 368, 452
Couplings, Hose & Tube..... 231 289, 315
Dampers 244
Die Casting Machines..... 368
Drives ..13, 107, 112-113, 329, 343 355, 372, 384, 425
Engines 383, 394, 419
Fasteners ...32, 35, 40-41, 51, 54 61, 79, 103, 126 258, 276, 312-313 320, 328, 348, 354, 365, 367, 388 399, 411, 417, 418, 445
Feeders 434, 443
Filters 422
Flexible Joints 347
Floats 280, 457
Furniture, Shop 331
Gages & Instruments.....219, 389
Gears ..42, 53, 91, Insert between pp. 96 & 97, 272, 279, 360 406, 409, 412, 438
Hose 15, 18-19, 231, 296
Hydraulic & Pneumatic Equipment ..1, 60, 231, 237, 275, 277 278, 310, 315, 341, 349, 355, 360 363, 380, 382, 385, 395
Insulation 356
Knives & Blades..... 390
Locks, Hinges 318
Lubricating Equipment 43, 59 229, 257, 266, 311, 457, 460
Materials Handling 67, 434
Mountings 244, 447, 452
Name Plates 398
Packings, Gaskets & Seals 2nd Cover, 4th Cover, 18-19, 33 56-57, 71, 97, 229, 289, 290, 298 301, 310, 314, 334, 358, 412, 422
Photographic Equipment ..303, 336
Piping 219, 329
Power Units 274, 278, 380, 382
Pumps ..237, 257, 274, 278, 292 368, 377, 380, 385, 396, 398, 430
Regulators 329
Rings ..4th Cover, 35, 103, 314, 367
Screw Machine Parts.....42, 374
Shafting, Flexible 420
Sheaves & Pulleys....112-113, 340
Shims 260
Slides 404
Speed Reducers & Motor Reducers..3rd Cover, 107, 118-119 287, 330, 335, 337, 343, 354
Spindles 269
Springs...332, Insert between pp. 356 & 357, 394, 412
Strainers 422
Testing Equipment ..219, 322, 447
Tapes 454
Transmissions ...329, 343, 384, 425
Traps 219, 289
Universal Joints 348

Index of

PRODUCTS ADVERTISED

In This Issue

•

Valves & Fittings....1, 43, 59, 219 257, 275, 280, 308, 310, 315, 327 329, 355, 360, 380, 382, 391, 398 406, 441, 442, 457
Vibratory Equipment 447
Vibration Dampers ...71, 242, 244 447, 452
Washers 365, 367, 381
Wheels & Castors..... 320
Wire Cloth 86, 256, 424

ELECTRICAL PARTS

Assemblies ..249, Insert facing p. 321
Brakes 104-105, 270, 378
Brushes .....4th Cover
Clutches 104-105
Coils 249
Connectors 360
Contacts... 4, 42, 87, 252, 284, 427
Controls & Control Equipment 4, 24-25, 50, Insert between pp. 64 & 65, 68-69, 85, 88-89 100-101, 118-121, 208, 217, Insert between 256 & 257, 272, 274, 278 282, 284, Insert facing p. 289, 357 382, 394, 416, 424, 427, 434 440, 455
Cords 63
Counters 348, 408
Couplings 14
Drives 53
Electronic Equipment.....106, 116 281, 397, 408, 427, 434
Extruded Plastics 223
Generators 265
Instruments .....116, 265, 281 Insert facing p. 289, 309, 434
Insulation.....223, 375, 400, 416
Insulators 397
Lamps 392, 427
Magnetos 52
Motors.....3rd Cover, 20-21, 22-23 30-31, Insert between pp. 32 & 33 93, 100-101, 108-109, 118-119, 122 246, 249 251, 254, 265, 285, 304 318, 323, 330, 335, 337, 350, 359 378, 392, 418, 421, 429, 432, 453
Solenoids.....271, 382, 398, 406 434, 440
Static Eliminators 404
Thermostats.....80, 221, 357
Timers 93, 453
Wire & Cable.....291, 342
Wiring Accessories..48-49, 63, 274 397, 427

DRAFTING ROOM EQUIPMENT & SUPPLIES

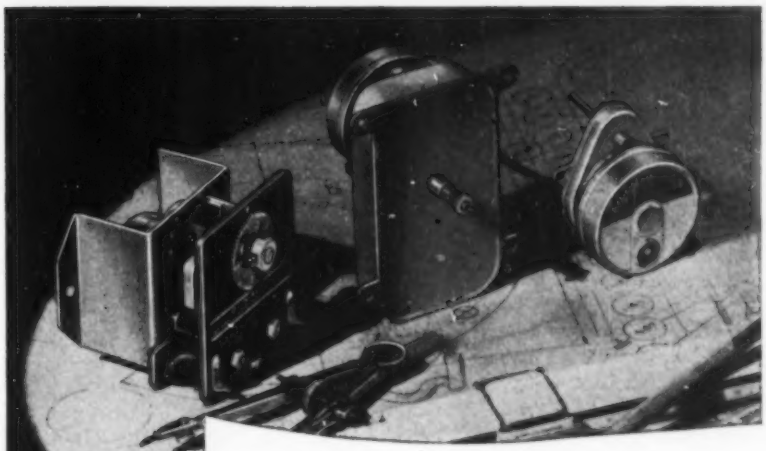
262, 288, 303, 320, 332, 400, 431

FABRICATING METHODS AND SERVICES

Bending 262
Die Casting 38
Die Making 38, 346
Drawing 82
Duplicating 262, 405
Extruding 268
Flame Cutting 405
Forming 82, 264
Gear Cutting..Insert between pp. 96 & 97
Grinding 91
Molding..6, 242, 268, 294, 322, 334 370, 422, 456
Rolling 369
Shearing 262
Stamping.....38, 82, 262, 432
Swaging 286
Welding.....258, 264, 329, 373, 401
Wire Wrapping 26-27

ENGINEERING & PRODUCTION SERVICES

36-37, 38, 64, 241, 264, 301, 346 369, 390, 401, 419, 428, 432 446, 459
Books 328



When called upon to

HARNESS TIME

Call in **HAYDON** AT TORRINGTON

HEADQUARTERS FOR **TIMING**

A.C. and D.C. TIMING MOTORS • TIMING DEVICES TIME DELAY RELAYS • SPECIAL TIMING DEVICES TIMING ENGINEERING SERVICES

HAYDON* specializes in a varied line of standard timing components and custom engineered devices for volume application.

Our research and engineering staffs are constantly seeking to develop new and better ways to harness time for industrial, commercial and military applications.

In the field, HAYDON maintains a staff of engineers whose training, backed up by years of experience, enables them to help manufacturers insure, insofar as timing components can, the satisfactory performance of their products. The entire staff and rapidly expanding plant facilities of HAYDON are devoted solely to the production of timing motors, timing devices and clock movements.

AT YOUR SERVICE

The knowledge and skill of our field engineers and our research and engineering facilities are available to help you solve timing problems. Write us in detail or ask that we send a field engineer to talk things over.

*TRADEMARK REG. U.S. PAT. OFF.

HAYDON Mfg. Co., Inc.

Subsidiary of GENERAL TIME CORP.

3134 ELM STREET

TORRINGTON, CONNECTICUT

This cork-and-rubber tape sticks to its sealing job

The cover gasket of an electrical junction box must stay in place no matter how many times the box is opened. Box manufacturers find Armstrong's DK-153 Tape ideal for this unusual sealing job.

This springy cork-and-rubber tape has a pressure-sensitive adhesive backing that holds the gasket firmly in place when cover is removed. The adhesive backing speeds production, too, for to apply a gasket, you simply peel off the protective cloth and press the part into place.

DK-153's resilience makes it ideal for many other jobs besides gasketing. For example, the tape is widely used to pack delicate parts for protection from shipping damage or to provide anti-skid pads.

You can get Armstrong's DK-153 Tape in a variety of widths and thicknesses, in sheets, rolls, ribbons, and die-cut shapes. For samples, write on your letterhead to Armstrong Cork Company, Industrial Division, 7310 Irvin Street, Lancaster, Penna.

ARMSTRONG'S
DK-153 TAPE

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Acme Tank and Welding Div., United Tool and Die Corp.... 283
Acushnet Process Co..... 242
Adams & Westlake Co..... 217
Adel Div., General Metals Corp. 275
Advance Electric & Relay Co... 424
Aeroquip Corp. 315
Aetna Ball & Roller Bearing Co. 293
Ahlberg Bearing Co..... 273
Aircraft-Marine Products Co..48-49
Ajax Flexible Coupling Co..... 235
Alden Products Co..... 427
Allegheny Ludlum Steel Corp.. 376
Allen-Bradley Co.
Insert between pp. 64 & 65
Allen Co., A. K..... 434
Allen Mfg. Co..... 399
Allied Products Corp..... 346
Allied Research Pdts. Inc..... 263
Allis-Chalmers Mfg. Co.....108-109
Allis Co., Louis..... 335
Aluminum Goods Mfg. Co.....36-37
American Blower Corp..... 425
American Brake Shoe Co..... 10
American Brass Co..... 403
American Chemical Paint Co... 266
American Cystoscope Makers, Inc 322
American Hard Rubber Co..... 268
American Insulator Co..... 370
American Lava Corp..... 111
American Radiator & Std. Sanitary Corp. 407
American Screw Co..... 32
American Steel Foundries, Inc. Level Load Axle Div..... 386
Ampco Metal Inc.....76-77
Anchor Coupling Co., Inc..... 289
Anti-Corrosive Metal Pdts..... 418
Arkwright Finishing Co..... 288
Armco Steel Corp..... 212
Armstrong Cork Co. (Gaskets, Packing & Seals) 56-57, 71, 454
Arrow Hart & Hegeman Elec. Co.
Insert between pp. 256 & 257
Arwood Precision Casting Corp. 423
Associated Spring Corp.
Insert between pp. 356 & 357
Atlantic India Rubber Wks. Inc. 322
Atlantic Screw Works, Inc..... 32
Automatic Electric Mfg. Co.... 416
Automatic Electric Sales Co... 208
Automatic Switch Co.....406, 442
Automatic Steel Products Inc.. 442

Bakelite Co., Union Carbide & Carbon Corp. 73
Bantam Bearings Div., Torrington Co. 78
Barry Corp. 244
Bausch and Lomb Optical Co... 451
Bead Chain Mfg. Co..... 286
Belden Mfg. Co..... 63
Belgian Electric Sales Corp... 421
Beryllium Corp. 364
Bethlehem Steel Co.....65, 72
Bird Co., Inc., Richard H..... 430
Blake & Johnson Co..... 32
Bodine Electric Co..... 337
Bower Roller Bearing Co..... 227
Brady Corp. 398
Brainard Steel Div., Sharon Steel Corp. 243
Breeze Corp., Inc..... 329
Bridgeport Brass Co..... 95
Brown & Sharpe Mfg. Co..... 116
Bundy Tubing Co..... 239
Bunting Brass & Bronze Co... 439

Cambridge Wire Cloth Co..... 424
Carpenter Steel Co..... 400
Carpenter Steel Co., Alloy Tube Div. 96
Cash Valve Mfg. Corp., A. W... 441
Central Screw Co..... 32
Chain Belt Co.....44-45
Chapman Electric Neutralizer Co. 404
Chase Brass & Copper Co., Inc. 366
Chicago Rawhide Mfg. Co.
2nd Cover

INDEX TO ADVERTISERS

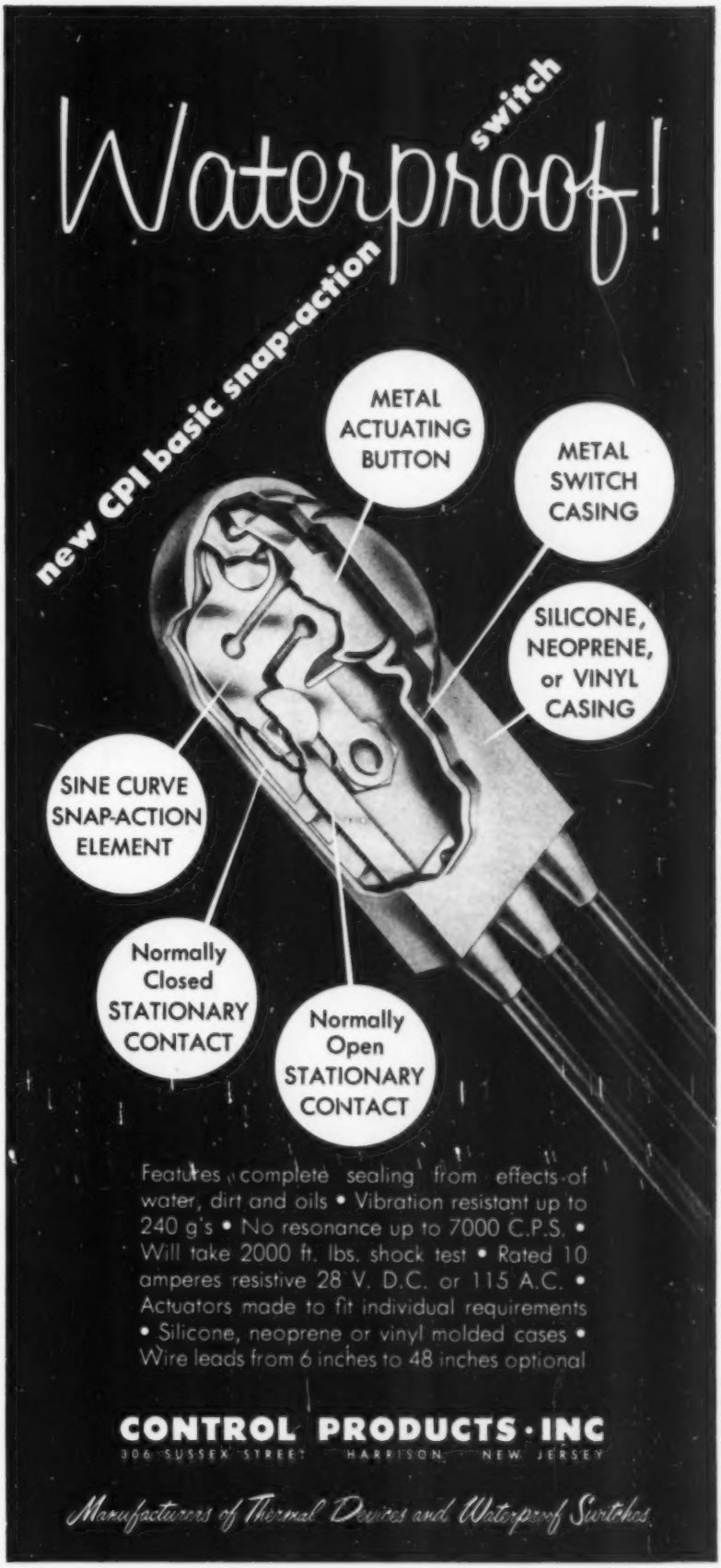
Chiksan Co. 347
Chrysler Corp. Industrial Engine Div. 383
Cincinnati Gear Co. 272
Cincinnati Industries Inc. 319
Clearprint Paper Co. 332
Cleveland Pneumatic Tool Co. 349
Climax Molybdenum Co. 432
Columbia-Geneva Steel Div., U. S. Steel Corp. 58
Comar Electric Co. 278
Consolidated Engineering Corp. 281
Continental Diamond Fibre Co. 47
Continental Rubber Works 422
Continental Screw Co. ...32, 312-313
Control Products, Inc. 455
Corning Glass Wks. 461
Cornish Wire Co., Wired Assembly Div.
Insert facing p. 321
Cramer Posture Chair Co., Inc. 331
Crane Co. 219
Crane Packing Co. 290
Curtis Universal Joint Co., Inc. 248
Cuyahoga Spring Co. 394

Darling Valve & Mfg. Co. 310
Dayton Rubber Co. 247
De Laval Steam Turbine Co. ... 409
Delco Products Div., Gen. Motors Corp. 122
Denison Engineering Co. 380
Detroit Coil Co. 434
Dialight Corp. 392
Diefendorf Gear Corp. 360
Dings Brakes, Inc. 270
Dodge Mfg. Corp. 340
Douglas Aircraft, Co., Inc. 356
Dow Chemical Co. 81
Dow Corning Corp.
Insert between pp. 324 & 325
Drop Forging Association 300
DuPont de Nemours & Co., Inc. E.I. Electrochemical Dept. Glass Ceramic 83
DuPont de Nemours & Co., Inc. E. I. (Plastics) 16, 92
Durakool, Inc. 272
Dynamatic Corp. subs. Eaton Mfg. Co. 14

Eagle Lock Co. 32
Eastern Air Devices, Inc. 285
Eastern Tool & Mfg. Co. 82
Eastman Kodak Co. Industrial Optical Sales Div. 389
Eastman Kodak Co. Industrial Photographic 303
Eastman Mfg. Co. 231
Eaton Mfg. Co., Dynamatic Corp. 14
Ebert Electronics Co. 394
Eco Engineering Co. 292
Elastic Stop Nut Corp. of America 103
Elco Tool & Screw Corp. 32
Electric Auto-Lite Co., Bay Mfg. Div. 307
Electric Auto-Lite Co., Wire & Cable Div. 291
Electric Wheel Co. 320
Electrical Engineering & Mfg. Corp. 359
Electro Dynamics Div. General Dynamics Corp. 304
Electro Engineering Pdts. Co. Inc. 432
Electrofilm, Inc. 280
Electrol, Inc. 308
Elliott Co. 378
Enthone Inc. 84
Evans' Sons, John 322

Fairbanks, Morse & Co. 350
Fairchild Aircraft Div., Fairchild Engine & Airplane Corp. 406
Farval Corp. 59
Fawick Airflex Div., Federal Fawick Corp. 297
Federal Bearings Co., Inc. 29
Federal Mogul Corp. (Equipment) 381
Federal Telephone & Radio Corp. 342
Federal Tool & Mfg. Co. 432
Felters Co. 402
Fenwal, Inc. 357

(Continued on page 456)

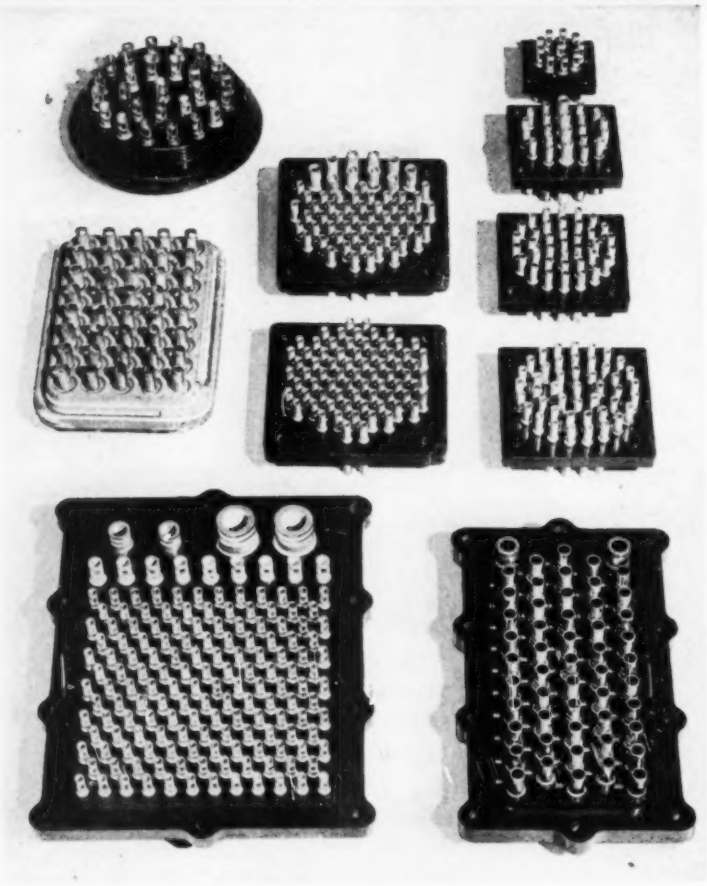

Waterproof! switch
new CPI basic snap-action
METAL ACTUATING BUTTON
METAL SWITCH CASING
SILICONE, NEOPRENE, or VINYL CASING
SINE CURVE SNAP-ACTION ELEMENT
Normally Closed STATIONARY CONTACT
Normally Open STATIONARY CONTACT
Features complete sealing from effects of water, dirt and oils • Vibration resistant up to 240 g's • No resonance up to 7000 C.P.S. • Will take 2000 ft. lbs. shock test • Rated 10 amperes resistive 28 V. D.C. or 115 A.C. • Actuators made to fit individual requirements • Silicone, neoprene or vinyl molded cases • Wire leads from 6 inches to 48 inches optional
CONTROL PRODUCTS · INC
306 SUSSEX STREET HARRISON, NEW JERSEY
Manufacturers of Thermal Devices and Waterproof Switches

Just a few of the many Disconnect Panels molded

for **BURNDY** *Engineering Company* INC.

by

KUHN & JACOB



ESTABLISHED 1919

Burndy disconnect panels for pressurized bulkheads must be molded with great precision and accuracy. The many metal inserts must be absolutely secure so as to allow fast, sure connections. KUHN & JACOB has met Burndy's exacting specifications for many years. Why not let us quote on YOUR requirements?

KUHN & JACOB MOLDING & TOOL CO.

1230 SOUTHARD STREET, TRENTON 8, N. J.

CONTACT THE K & J REPRESENTATIVE NEAREST YOU

S. C. Ullman, 55 W. 42nd St., New York, N. Y. Telephone—Penn 6-0346

Wm. T. Wyler, Box 126, Stratford, Conn. Telephone—Bridgeport 7-4293

Wm. A. Chalverus, Carson Road, Princeton, N. J.

INDEX TO ADVERTISERS

(Continued from page 455)

Flexonics Corp. 284
Flex-O-Tube, Div. of Meridan Corp. 296
Foote Bros. Gear & Machine Corp. 53
Ford Instrument Co. Insert between pp. 288-289
Formsprag Co. 333
Fulton Sylphon Div., Robertshaw-Fulton Controls Co.... 110
Funk Aircraft Co. 384

Garlock Packing Co. 298
Gast Mfg. Corp. 278
Gates Rubber Co. 372
Gear Specialties 91
General Dynamics Corp. Electro Dynamics Div. 304
General Electric Co., Apparatus Dept. Insert between pp. 32 & 33 118-121
General Industries Co. 246
Gerotor May Corp. 285
Gits Bros. Mfg. Co. 229
Gleason Works Insert between pp. 96 & 97
Glidden Co., The 345
Globe Steel Tubes Co. 437
Goodrich Co., B. F. (Rivnut).. 51
Goodrich Co., B. F., Bealing Zipper Div. 97
Goodyear Tire & Rubber Co. (Mech. Gds.) 15
Graham Transmissions, Inc.... 343
Grammes & Sons, Inc., L. F.... 398
Grant Pulley & Hardware Co... 404
Gray Iron Founders' Society Inc. 415
Great Lakes Screw Corp. 32
Great Lakes Steel Div. Nat'l. Steel 299
Gries Reproducer Corp. 428

H & R Industries 420
Handy & Harman 259
Hanna Engineering Works 363
Harper Co., H. M. 32
Hart Mfg. Co. 282
Hartford Steel Ball Co. 332
Hartwell Aviation Supply Co... 318
Haydon Mfg. Co., Inc. 453
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 305
Heim Co. 102
Heinze Electric Co. 392
Heli-Coil Corp. 411
Herbrand Div. of the Bingham-Herbrand Corp. 348
Hilliard Corp. 336
Hills-McCanna Co. 257
Hitchiner Mfg. Co. (Metal Pdts. Sales Co.) 426
Hoover Co., Electric Motor Div. 20-21
Houghton & Co., E. F. 341
Houghton Laboratories Inc.... 428
Howell Electric Motors Co. 429
Hyatt Bearings Div. General Motors 74-75

Imperial Pencil Tracing Cloth. 320
Improved Seamless Wire Co... 428
Indiana Gear Works 279
Instrument Specialties Co., Inc. 412
International Nickel Co., Inc... 66
Irvington Varnish & Insulator Co. 223

Johns-Manville Corp. (Packings) 358
Johnson Bronze Co. 413
Jones & Laughlin Steel Corp... 90

KSM Products Inc. 258
Kaiser Aluminum & Chemical Corp. 325-326
Kaydon Engineering Corp. 225
Keller Tool Co. 26-27
Ketay Mfg. Corp. 106
Kollsman Instrument Corp. Div. Std. Coil. 265
Koppers Co., Inc. Plastics Div. 338
Kraisal Co. 422
Kuhn and Jacob Molding & Tool Co. 456
Kurz Kasch, Inc. 6

INDEX TO ADVERTISERS

Laminated Shim Co., Inc. (Shim) 260
Lamson & Sessions Co.....32, 79
Landis & Gyr, Inc..... 310
Lear, Inc. 377
Leland Inc., G. H..... 271
Librascope, Inc. 434
Linde Air Products Co. Unit of Union Carbide & Carbon Corp. 373, 405
Linear, Inc. 314
Link Belt Co..11, 13, 67, 98-99, 107
Lion Fastener, Inc..... 348
Lord Mfg. Co.....452
Lovejoy Flexible Coupling Co.. 368
Lycoming Divisions—Avco Mfg. Corp. 419

McGill Mfg. Co., Inc..... 233
McGraw-Hill Book Co., Inc.... 328
McLouth Steel Corp. Insert facing p. 320
M B Mfg. Co., Inc..... 447
Malleable Founde.s Society.... 410
Mallory & Co., Inc. P. R.....4, 50
Manhattan Rubber Co.....18-19
Marion Electrical Instrument Co. 309
Master Electric Co. (Speed-master) .....3rd Cover
Mercury Clutch Div., Automatic Steel Pdts. Inc..... 442
Metals & Controls Corp., General Plate Div..... 87
Metals & Controls Corp. Spencer Thermostat Div.... 80
Metron Instrument Co..... 354
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 88-89
Midland Steel Pdts. Co..... 328
Midwest Plastic Pdts. Co..... 322
Milford Rivet & Machine Co... 276
Miller Motor Co..... 395
Minnesota Mining & Mfg. Co.. 94
Minnesota Rubber & Gasket Co. 334
Monsanto Chemical Co..... 210
Mt. Vernon Die Casting Corp.. 46
Mueller Brass Co..... 306

National Bearing Div., Amer. Brake Shoe 321
National Lead Co..... 38
National Lock Co..... 32
National Lock Washer Co. (Retaining Rings) 367
National Malleable & Steel Casting Co. 245
National Motor Bearing Co., Inc. 33
National Screw & Mfg. Co..32, 445
National Steel Corp..... 255
National Tube Div. U. S. Steel Corp. 58
Nat onal Vulcanized Fibre Co. 31
Newark Wire Cloth Co..... 256
New Departure Div., Gen. Motors Corp. 128
New Jersey Zinc Co..... 12
Newton Insert Co..... 320
Nry Co., J. M..... 252
Nicholson & Co., W. H..... 280
Norgren Co., C. A..... 311
Nugent & Co., Inc., Wm. W.... 457

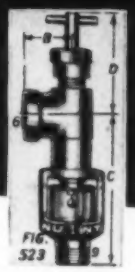
Ohio Knife Co..... 390
Oilgear Co..... 355
O'Neil Irwin Mfg. Co..... 262
Orange Roller Bearing Co., Inc. 55
Ortman Miller Machine Co..... 277

Packard Electric Div. General Motors 251
Parker-Kalon Corp.....32, 40-41
Parker Rust Proof Co..... 8
Parker White Metal Co..... 344
Peerless Electric Co., Motor Div. 323
Peerless Photo Products, Inc.. 431
Penn Metal Co., Inc..... 253
Pennsylvania Salt Mfg. Co..316-317
Perkins Machine & Gear Co.... 438
Pheoll Mfg. Co..... 32
Pittsburgh Plate Glass Co. Brush Div. 314

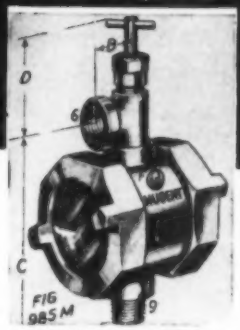
(Continued on page 458)

See...Don't Guess

Install NUGENT Sight Feed Valves for LUBRICATION CONTROL



13 models designed for working pressures to 125 psi. Sizes to ¾ inch.

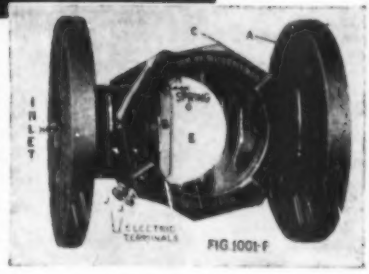


9 models for large machinery. "Swivel and lock" type for sight chamber adjustment to most convenient view position.

Medium size needle type with steel valve stem. 9 models. Sizes to ¾ inch.

WITH a Nugent Sight Feed Valve in your oil line, you can tell at a glance whether or not vital parts are receiving proper lubrication. Nothing is left to chance and there's no guess work involved. Oil flow tthrough the valve is controllable from 2 drops per min. to 21 gals. per hour depending upon oil viscosity and valve model. All are vented to prevent air binding. Glasses and screens are removable for cleaning without interrupting oil flow.

SIGHT FLOW INDICATORS



Sight Flow Indicator available with tapped or flanged connections. Removable windows. Can be installed right or left hand or vertically.

ANOTHER NUGENT instrument for solving lubrication problems is the Sight Flow Indicator. Installed in a machinery oil system, this device sounds an alarm when oil is not getting to bearings. When oil is not flowing properly, Indicator "B" (See Fig. 1001-F) closes making contact with terminals "J". This sounds the alarm making it possible to locate trouble quickly, protect valuable machinery and save on costly down time.

For trouble free lubrication systems, write for descriptive bulletin on the Nugent Sight Feed, Sight Flow Indicator and other Lubrication Specialties.

Wm. W. Nugent & Co., Inc.
441 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Your 1955 Models Require New Sealing Compounds Today

Sealing Compounds, Adhesives and Coatings for air conditioning, aircraft, appliances, aluminum windows, automobiles, breweries, bridges, cold storage, concrete curing, communications, dams and locks, excavation work, fuel tanks, greenhouses, highways, housing, railroad cars, refrigerators, reservoirs, sewers, storage tanks, trailers, trucks, and many other products and industries.

As often as designs change in automobiles, air conditioners, refrigerators and hundreds of other products . . . new sealing problems arise. Staple, stock-in-trade sealants are not always the most effective answer.

Presstite's Research and Development Laboratories, specializing exclusively in sealing compounds for more than 24 years, thrive on the challenge to formulate new sealants for new products, new models, new requirements.

If you contemplate new, improved models, remember to protect the quality and performance you so carefully plan. Consult our experienced sales engineers, who will be glad to work closely with you in recommending or having our laboratories formulate the very best sealant for your needs.

In Canada: Railway & Power Engineering Corp., Ltd.

PRESSTITE SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY

3750 Chouteau Ave. **St. Louis 10, Mo.**

INDEX TO ADVERTISERS

(Continued from page 457)

Pittsburgh Plate Glass Co. Fibre Glass Div. 352
Platecoil Div. of Tranter Manu. Inc. 250
Pneu-Trol Devices Inc. 360
Polymer Corp. of Pennsylvania 444
Pope Machinery Corp. 269
Potter Instrument Co. 408
Power Products Corp. 394
Presstite Engineering Co. 458
Production Instrument Co. 348
Projectile & Engineering Co. Ltd. 368

RBM Div. Essex Wire Corp. 284
Raybestos-Manhattan Inc. 18-19
Equipment Sales Div.
Manhattan Rubber Div.
Packings Div. 18-19
Republic Steel Corp. (Steel & Tubes) 261
Research, Development, Manufacture Inc. 42
Resinite Corp. 400
Revere Copper & Brass Inc. 2
Reynolds Wire Div., National Standard Co. 86
Rhode Island Tool Co. 384
Riverside Mfg. & Elec. Supply Co. 274
Riverside Metal Co. 435
Rivett Lathe & Grinder Inc. 382
Robbins & Myers Inc. 30-31
Rochester Ropes 295
Rockford Clutch Div. Borg Warner Corp. 392
Rockford Screw Products Co. 32
Rockwood Sprinkler Co. (Ball Valve Div.) 391
Rogers Corp. 301
Roller Bearing Co. of America 393
Roll Formed Products Co. 369
Rollway Bearing Co., Inc. 433
Ross Operating Valve Co. 1
Russell, Burdsall & Ward Bolt & Nut Co. 417
Ruthman Machinery Co. 368
Rynel Corp. 330

SKF Industries, Inc. 114-115
Saginaw Steering Gear Div., General Motors Corp. 374
Saran Lined Pipe Co. 446
Schatz Mfg. Co. 28
Sciaky Bros., Inc. 401
Scintilla Magneto Div., Bendix Aviation Corp. Elect. Conn. 360
Scintilla Magneto Div., Bendix Avia. Corp., H&K Magnetos Div. 52
Scovill Mfg. Co. 32, 117
Screw Research Association 32
Shakeproof Div. of Ill. Tool Works 32, 365
Simmons Fastener Corp. 61
Skinner Electric Valve Div. Skinner Chuck Co. 442
South Chester Corp. 388
Southington Hdwe. Mfg. Co. 32
Spaulding Fibre Co., Inc. 255
Speer Carbon Co. 241
Split Ball Bearing Co. 384
Sponge Rubber Products Co. 324
Square D Co. 68-69
Staedtler Co., J. S. 262
Standard Pressed Steel Co. 54
Standard Tube Co. 302
Stanley Chemical Co. 416
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co. 254
Steel Founders' Society of Amer. 371
Stephens-Adamson Mfg. Co. 362
Sterling Bolt Co. 32
Sterling Electric Motors Inc. 418
Stevens Mfg. Co., The 221
Stewart Warner Corp. (Alemite) 43
Stewart Die Casting Div. Stewart Warner Corp. 62
Strom Steel Ball Co. 252
Strong, Carlisle & Hammond Co. 354
Stronghold Screw Products, Inc. 32
Stupakoof Ceramic & Mfg. Co. 397
Superior Steel Corp. Insert facing p. 288
Synthane Corp. 387

INDEX TO ADVERTISERS

Taylor Fibre Co. 379
Telechron Dept., General Electric Co. 93
Teleflex, Inc. 420
Thomas Flexible Coupling Co.. 248
Thompson Products Inc. 327
Timken Roller Bearing Co. (Industrial) 39
Tinnerman Products Inc. 126
Titchener & Co., E. H. 459
Torrington Co., Bantam Bearings Div. 78
Torrington Co. (Specialty) 64
Trabon Engineering Co. 460
Transicoil Corp. 249
Transue & Williams Co. Stamping Div. 351
Tri-Clover Machine Co. 339
Tuthill Pump Co. 396

Union Carbide & Carbon Corp. Bakelite Co. 73
Haynes Stellite Co. 305
Linde Air Products Co. ..373, 405
Unitcast Corp. 267
United International Research, Inc. 404
United Mfg. Co. 264
U. S. Electrical Motors Inc. ..22-23
U. S. Graphite Co. ..... 4th Cover
U. S. Rubber Co. 34
U. S. Steel Export Co. 58
U. S. Steel Supply Co. 58
Universal Drafting Machine Co. 400

V & O Press Div. Emhart Mfg. Co. 443
Valcor Engineering Corp. 398
Van Huffel Tube Corp. 353
Veeder-Root Inc. 17
Vellumoid Co. 412
Vickers Inc. 60
Viking Pump Co. 430

Waldes-Kohinoor Inc. 35
Wales-Beech Corp. 32
Warner Elec. Brake & Clutch Co. 104-105
Watertown Mfg. Co. 294
Webster Electric Co. 237
Welco Motors 318
Wesche Elec. Co., B. A. 318
Westinghouse Electric Corp. ..24-25 85, 100-101
Winsmith Inc. 287
Winzeler Mfg. and Tool Co. .. 406
Wollensak Optical Co. 336
Wolverine Tube Div., Calumet & Hecla Inc. 70
Worcester Gear Works, Inc. 412
Worthington Corp. Multi-V Drive 112-113

Yoder Co. 264

■

PROFESSIONAL SERVICES ... 445

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

EMPLOYMENT
Positions Vacant 449, 450
Positions Wanted 450
Employment Services 450

SPECIAL SERVICES
Contract Work 450

BUSINESS OPPORTUNITIES
Wanted 449, 450

■

Advertisers' Index starts on 454
Product Index starts on... 451

"Simplicate it, and add more lightness!"

. . . The goal of modern industry — as expressed by one of America's greatest research engineers.

That's the sole objective of the *Titchener Test:* To see whether a product—yours, for example—can be made simpler . . . lighter . . . cheaper.

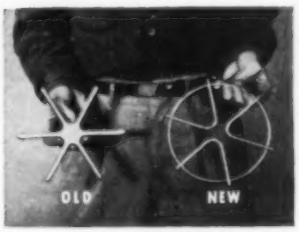
Here's How The *TEST* Works

Say the design of your product includes a casting or forging, stamping, tubing or sheet steel part. You send prints or a sample of the part to Titchener. A group of wire-forming engineers studies it from all angles . . . function, design, cost. If they find that wire can do a better job they'll submit estimates or a sample of the revised piece for your consideration. If they honestly feel wire can't improve your product, they'll tell you that, too.

The Titchener Test costs you nothing . . . imposes no obligation. It's unbiased and confidential. Merely send print or a sample . . . describe your wants in a covering letter.

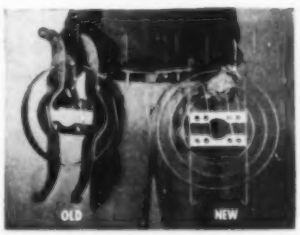
"Simplicated" Case Histories

Selected from among some 200 manufacturers who have taken the *Titchener Test* . . .



Saves Manufacturer $4,015!

Design of new portable stove submitted to Titchener called for die-cast burner grate. Tool cost for die casting quoted at $3,000 — estimated unit cost, 30¢. Titchener designed simple wire grate. Tool cost, $235; unit cost, 25¢. Savings on first order for 25M — $4,015.



Wire Design Reduces Weight 75%

The sheet steel motor mount shown at left was replaced by the Titchener-designed welded wire-and-strip assembly at right. Result: Weight reduced 75%. Costs reduced. Availability of material improved. Appearance much improved.

Send for *FREE* Handbook!

"Use of Wire Construction in Product Design"

An illustrated 20-page technical handbook sent free to management, production, purchasing and engineering men. Write for your copy.

WIRE GOODS Headquarters

E. H. TITCHENER & CO.
67 Clinton St. Binghamton, N. Y.
Manufacturers of Wire Parts for Over 65 Years

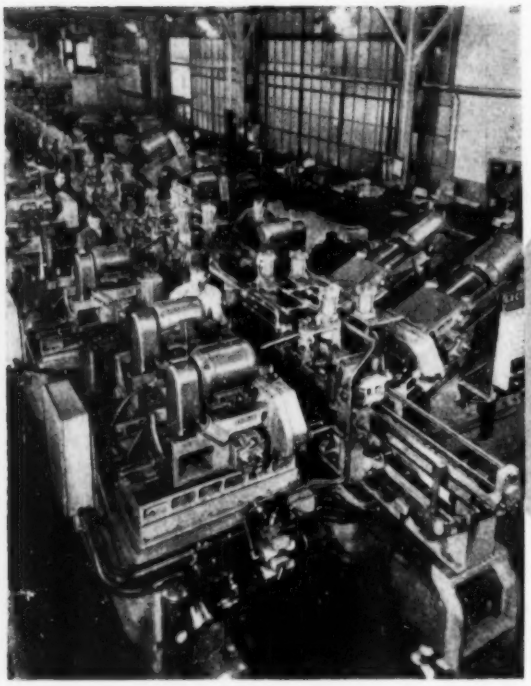


Photo Courtesy Ex-Cell-O Corp., Detroit, Mich.

Trabon

AUTOMATIC LUBRICATION
used on transfer machines
in large automotive plant

this has a BEARING on the subject

Illustrated here are transfer machines typical of several installed in the manufacturing plant of a large automotive producer . . . the first of which was put in operation during the early part of 1951.

Each of these machines is being automatically lubricated with a TRABON system. Two systems cover 195 bearing points each; two, 151 points each; and two, 305 points each.

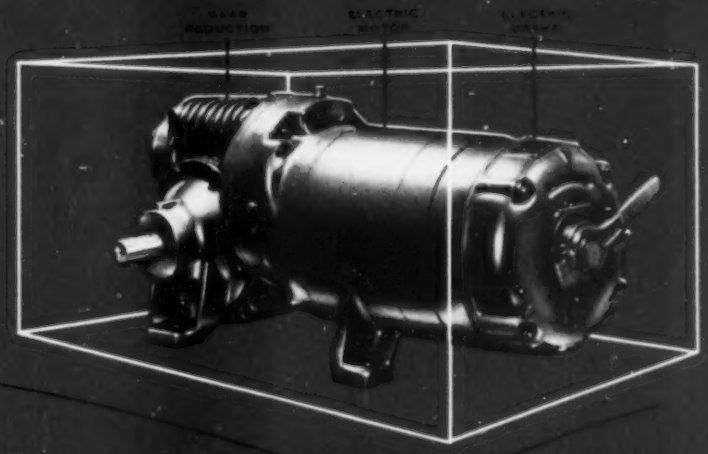
Each system is so proportioned that slides, ways and heavily loaded working bearings receive the proper amount of lubricant every 20 to 30 minutes. All minor bearings on fixtures receive the exact amount of lubricant required every four hours.

Whether your problem is to lubricate a hot metal crane, crushers, ore unloaders, presses, rolling mills, blast furnaces, boring mills, or any other industrial application . . . a TRABON system is your answer.

Completely sealed—positive—hydraulic—handles oil or grease—backed by years of experience.

WRITE FOR BULLETIN 529

Trabon **ENGINEERING CORPORATION**
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems



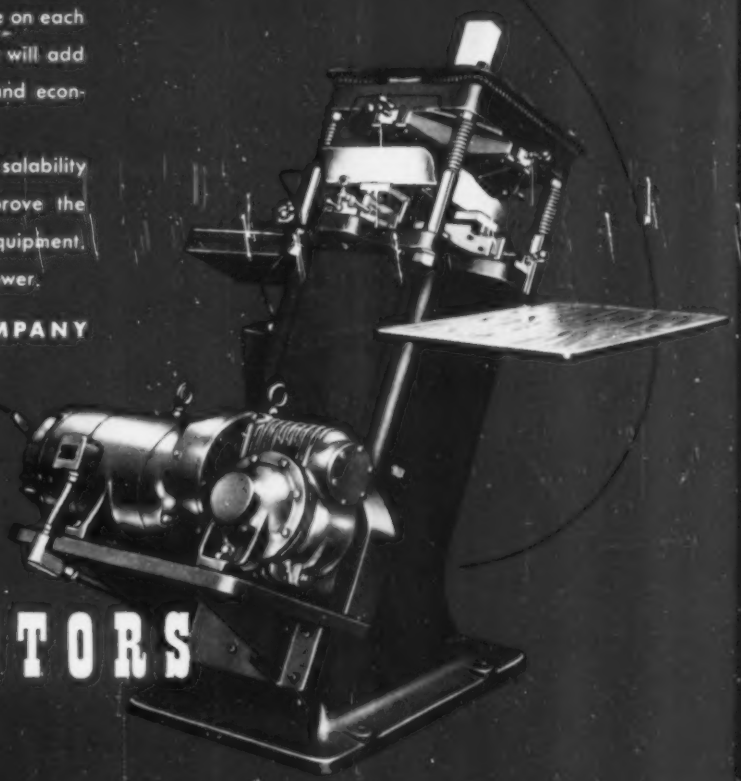
Don't put up with make-shift assemblies when it is so easy to get the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact, easy to use power package.

All in one package

Master Gearmotors, available in thousands and thousands of combinations of types and ratings, permit you to use a power drive on each job that's just right . . . a power drive that will add greatly to the compactness, appearance, and economy of each of your applications.

Use Master Gearmotors to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment. They're the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO



MASTER GEARMOTORS

GRAMIX® BEARINGS help insure efficient operation of MILLERS FALLS Power Drills

There are many reasons why Millers Falls No. 912 ½-in. and No. 1814 ¼-in. Power Drills operate on GRAMIX bearings. GRAMIX bearings help absorb the thrust load and maintain alignment of the drill shafts. They help to insure efficient operation and long, dependable service. Having a porous structure which makes it possible to oil-impregnate them during manufacture, they provide a constant film of oil at the bearing surface for the life of the drills. The ten bearings in these two popular drills are typical of the hundreds of applications in which GRAMIX has improved performance and helped insure the useful life of the product.

• GRAMIX is compacted from powdered metals under pressures up to 70,000 psi., and sintered in high temperature furnaces to produce strong, tough bearings, gears and other parts that will usually out-perform and outlast similar machined parts. They can be formed in relatively complicated shapes to tolerances as close as .0003″. GRAMIX parts need little or no machining, thus virtually eliminating scrap loss and waste. In production quantities, GRAMIX parts cost considerably less than machined parts.

GRAMIX CATALOG FREE

The new GRAMIX *Catalog is full of facts and figures, charts and data that show how you can save money and improve the performance of your products with* GRAMIX *parts. Write for it today.*

97

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN